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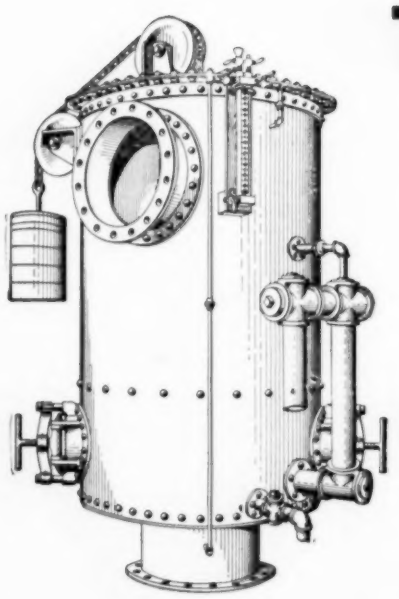

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THE LIGHTING OF FACTORIES AND WORKSHOPS.

By an OCCASIONAL CORRESPONDENT.

An important event in England has been the issue of the Report of the Departmental Committee, appointed by the Home Secretary in 1913 to study the lighting of factories and workshops.

During the last few years there has been a great deal of discussion on this subject both in Europe and the United States, and the home office, by the issue of this report, has given emphatic recognition of good lighting in industrial operations.

The report is a very comprehensive document. Nineteen pages are given up to the report proper, and a further 67 pages devoted to appendices, containing a summary of the experiments and other researches carried out by the committee. The committee includes among it members Dr. Glazebrook, the Director of the National Physical Laboratory, Sir Arthur Whitelegge, H.M., Chief Inspector of Factories, and Mr. L. Gaster who is the Hon. Secretary of the Illuminating Engineering Society in London. In the course of its enquiry the committee studied, through the foreign office, the legislation bearing on factory lighting in Austria, Belgium, Denmark, France, Germany, Holland, Italy, Norway, Sweden and the United States. In all these countries there is some reference to adequate industrial lighting in the legislative codes, so that there is good ground for an investigation of the subject.

The present report is a uninque study, such as has not been published in any other country. Fifty witnesses, including factory inspectors, representatives of trade associations representing both employers and employees, and delegates of the chief scientific and technical societies interested, were examined. In addition, the committee visited personally the chief industrial centers in England, and had about 4,000 measurements of illumination made in various factories. The inquiry showed that there has been a great advance in factory lighting during recent years, but there are still some workshops that have lagged behind in the general advance. A statistical enquiry was made into the number of accidents during each month of the year, and the results point to the conclusion that inadequate lighting is a contributary cause of accidents in factories, a conclusion that is supported by the evidence of various witnesses regarding the conditions in shipyards, foundries and cotton mills, and by the statement of the Accidents Offices Association (which includes most of the insurance companies interested

A view of a factory lighted by high pressure gas. Illumination in centre gangway, 1.5–3.5 foot candles, on lathes and benches, 10–12 foot candles.

in the Workmen's Compensation Act.). In addition, complaints of eyestrain, headache, etc., due to insufficent lighting, are frequent, and there is a very general opinion that unsatisfactory lighting is, in various ways, prejudicial to health. Reference is also made to the effect of improved lighting in increasing the output and improving the quality of work, and in aiding the supervision of employees.

As a result of their investigations, the Committee have come to the conclusion that there should be statuary provision (a) *requiring adequate and suitable lighting in factories*, and (b) *giving power to the Secretary of State to make orders defining adequate and suitable illumination for factories and workshops, or for any part thereof, or for any process carried out therein.*"

Certain standards desirable in the interests of safety and convenience are also prescribed, such as 0.25-ft. candles in the working areas of factories, 0.4-ft. candles in foundries; 0.05 in open yards and approaches, etc., are also recommended. It is to be noted that these values are quite apart from the much higher values of illumination desirable for the actual carrying out of industrial processes, which naturally vary according to the nature of the work. The committee do not feel prepared as yet to recommend standards of the latter kind ; it is pointed out that the values suggested in the interests of safety and convenience are intended as " practical legal minimums," which involve no hardship and would merely serve the purpose of raising the level of illumination in those factories that are behind the times. The committee also emphasize the view that " adequate lighting " is not a matter merely of numerical values, but includes attention to such points as safeguards against glare, proper distribution of light and avoidance of inconvenient shadows.

The very comprehensive series of measurements carried out by the committee proves that in modern workshops the prevailing values should be well above those suggested above. The current issue of the " Illuminating Engineer " (September, 1915,) which contains a complete summary of this report, also gives the results of some tests in a typical workshop lighted by high pressure gas which support this view. For example, the illumination in the gangways is given as 1.5–3.5-foot candles, while at the point of work on lathes and benches as much as 10-foot candles was recorded. A view of this workshop is reproduced on page 257.

There is no doubt that the report will give a great stimulus to industrial lighting, and it is remarkable that this good piece of work should have been carried to completion in spite of the dislocation produced by the war. It is pointed out, however, that in view of the great pressure upon many factories engaged on Government work, and also in view of the approaching season of the year when artificial light is mainly employed, the appearance of the report is very opportune.

Government Regulation of Water Powers in European Countries.

One of the most important problems in the political economy of a nation is the control of the water power. That Congress recognizes the importance is shown by the time devoted to the subject by the United States House of Representatives during the latter part of 1914. It is always interesting and usually helpful, in considering such a problem, to see how other countries have dealt with similar conditions; and Paper 238—The Public Utility of Water Powers and their Governmental Regulation—issued by the Geological Survey in 1910, contains much valuable information. This report, prepared by René Tavernier, chief engineer of the Department of Public Works of France, in conjunction with the Survey, tell the way in which France, Switzerland and Italy have dealt with the problem of utilizing the water powers afforded by the streams in those countries. The French regulations take cognizance of two kinds of streams—first, rivers that are navigable neither for vessels nor rafts, over which the French minister of agriculture exercises certain police powers and in which the riparian landowners possess certain rights ; and second, streams that are navigable by vessels or rafts, which lie within the public domain and are administered by the minister of public works. In Switzerland control of watercourses that are navigable for neither ships nor rafts, is retained by the cantons and communes. In Italy the waters are public property, concessions for development being issued by the Government.

The laws in force in France, Switzerland, and Italy are given in the report, together with a brief discussion of the results of their operation, as well as their defects and the probability of future changes in the laws.

Measuring the Gas Supplied to Panana-Pacific Exposition.

When the Pacific Gas and Electric Company contracted to furnish gas to the Exposition grounds it was necessary to measure the total quantities supplied to the Exposition and to the Zone, and the measurement had to be made in lines carrying from 30 to 50 pounds gauge pressure. Thomas meters were chosen for the work and installed in underground pits, which give results directly in standard cubic feet regardless of variations in pressure.

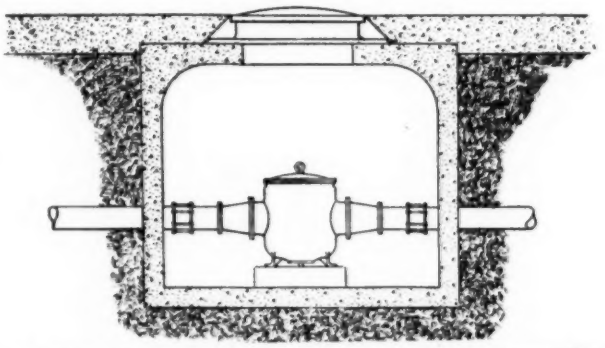

Fig. 1.—Cross Section of Underground Pit Showing Thomas Meter installed in Gas Line.

Fig. 1 shows a pit and Fig. 2 the building in which the recording panels were housed. The building is in the Exposition grounds just to the rear of the " Old Red Mill," and the pits containing the housings are about 500 feet distant, one in the line supplying the Exposition proper, and the other in the line to the Zone.

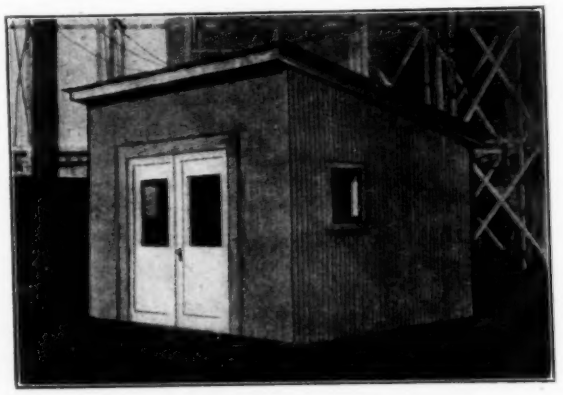

Fig. 2.—Small Building just to the rear of the "Old Red Mill" which Houses the Recording Panels for both Thomas Meters.

The Thomas meter measures electrically the heat required to raise the temperature of the flowing gas 2° F. The heat capacity of the standard unit, that is, the quantity of heat required to warm a standard cubic foot through a known temperature range, remains essentially the same even when the pressure and temperature of the gas change, so the meter dial and chart register standard units of gas whatever the pressure, temperature, or volumetric conditions. No corrections need be applied for gas temperature, pressure, or gravity, or for barometer reading, and the meter is entirely automatic, requiring very little attention or care.

War Changes in Gas Prices in Germany.

The replies to a letter of inquiry sent to German gas works by the Central Gas Publicity Organization of Berlin, published in the " Journal für Gasbeleuchtung," show the changes in the price of gas made in consequence of war conditions in German towns. In nine towns there has been some reduction in price ; in thirty-four towns differential prices for gas, according to whether it was used for lighting or cooking and heating have been changed to a uniform or flat rate for all purposes. The result is that gas used for lighting is obtained at a lower rate than formerly ; but it is impossible to say from the figures published whether the new system of charging has brought an increase or a decrease in the average price for all gas sold. In seventy-two towns there has been increases in price varying from 1 to 3 pf. per cubic meter [from 6 to 20 cents per 1,000 cubic feet].

GAS AS A CASE-HARDENING AGENT.

[By ALFRED H. WHITE and HOMER T. WOOD, to the Michigan Gas Association.]

It has been known for centuries that it is possible to form a hard steel skin upon mild steel articles, by imbedding them for a number of hours in chaircoal, maintained at a red head. Within recent years scientific investigation has shown that it is not the solid carbon that exerts the most powerful carbonizing action, but that it is the gaseous carbon monoxide, formed through the action of air enclosed in the spaces between the carbon grains or evolved from materials added, which effects the case-hardening. The most comprehensive studies have been made by Giolitti, who has issued a book on the subject, which has been recently translated into English. He strongly favors carbon monoxide as a carburizing agent, and states that hydrocarbons in high concentration are objectionable.

Illuminating gas has been used for some years, commercially, as a case-hardening agent in this country, with excellent results in the hands of some operators, and with indifferent success in the hands of others. The case-hardening of steel is an important industry, and is usually carried out in cities of sufficient size to have gas plants, so that the study of the advantages and limitations of illuminating gas as a case-hardening agent is of material importance to the gas industry and also to the metallurgical industry.

The results of our tests show that it is possible to produce excellent results and almost any type of case-hardening, with unenriched coal gas. There is no reason to doubt that any of the usual types of city gas will accomplish the same results, and that the method is capable of wide and advantageous commercial applications. In the following discussion there will be a brief review of the general processes of carburization, followed by a more specific discussion of the methods to be used in carburizing with gas.

The General Processes of Case-Hardening.—The purpose of case-hardening is to produce steel objects with a hard resistant surface over a soft tough center or core. The objects are first machined out of plain carbon or alloy steel, containing generally less than 0.25% carbon, which is soft and tough and easily machined. Their surface is then carburized, i. e., the surface is changed from a low carbon steel, to high carbon steel that will harden on heat treatment, and produce an object with a hard, resisting surface, and a tough, ductile core; so that the object cannot be easily broken. This carburizing is accomplished by exposing the steel at high temperature to the action of a carburizing agent. The carburizing agent, which is the source of available carbon, may be solid, such as charcoal, bone or leather scrap, with mineral matter such as barium carbonate frequently added, a liquid such as molten cyanides, or a gas such as illuminating gas, carbon monoxide, or oil gas. There are five factors that govern the process of carburizing: 1, the composition of the steel; 2, the nature of the carburizing agent; 3. the temperature of the carburizing; 4, the concentration of the carburizing agent and the intimacy of its contact with the steel; 5, the duration of curburizing. The quality of the finished piece depends also on the nature of the subsequent treatment. In order to produce a hard surface the pieces must be quenched from above their critical temperature, but if the steel is quenched directly from the carburizing heat it will be brittle, and the structure of case and core will be course and weak unless the temperature of carburizing has been held very low, or unless the raw material contains one of the alloying elements that retard grain growth. If the carburized steel is allowed to cool, and is then reheated to a temperature only high enough to refine the grain of the high carbon case, and is then quenched from that temperature, the grain of the carburized zone will be very fine, but that of the core will still remain as coarse as at the end of the carburizing operation. In this condition the line of demarcation between case and core is vary sharp.

In order to get the toughest possible steel, the piece must be cooled from the carburizing temperature in such a way as to avoid oxidation as much as possible. It is advisable to cool slowly in the boxes, but if the pieces are of such size and shape that they can be removed from the carburizing while hot, they may be quenched at this state. The steel should then be reheated just above the refining temperature of the low carbon core, and quenched in oil and warm water. This gives a fine grain to the core but leaves the surface with somewhat coarse grain. The piece should then be reheated to a temperature just above the critical temperature of the high carbon surface and quenched in water. It will then have a very hard surface with the finest possible grain. Generally the surface will be harder than necessary, but by reheating to a temperature below the critical temperature it is possible to draw the temper, reduce the hardness and, at the same time, greatly toughen the piece, while also reducing its brittleness.

Each of the five factors governing the carburization process will be considered separately in the light of the literature on the subject. A list of the references cited will be found at the end of the paper, and in the discussion, reference to them will be by number.

The influence of the composition of the steel on the case-hardening process is discussed in References 12, 14, 18, 21 and 27. The absorption of carbon is favored by those special elements that exist as double carbides, such as manganese, tungsten, chromium and molybdenum, and is opposed by those that form solid solutions with iron, such as nickel, silicon and aluminum. Nickel, while it seems to decrease the percentage of carbon in the case, seems to increase the rate of penetration. (Ref. 27.) Manganese should not be above 0.25%, or else the case will be brittle. Carbon is more rapidly absorbed by low carbon steels, but if they are used more carbon must be taken up in order to get the desired per cent., so that time is saved by using a medium carbon steel rather than a low carbon steel. For general case-hardening, the steel should be tough and show a high elongation, but yet should machine easily. A popular steel for this purpose contains 0.15–0.25% carbon and not more than 0.04% sulphur and phosphorus. Another very tough steel, and one very resistent to elastic fatigue, contains carbon up to 0.25% and, in addition to the regular elements, nickel of about 1.25–1.50% and chromium 0.5–0.6%. Either the carbon steel or this low chrome steel will carburize readily by any of the standard methods.

Nature of the Carburizing Agent.—Carburizers may be solid, liquid or gaseous. Liquid carburizers are the molten cyanides or ferrocyanides, and are used only when a very thin superficial case is desired. Small pieces of metal will be carburized to a depth of 0.001 to 0.003 inch after only a few minutes immersion in the molten bath. A deep case may be obtained by a long immersion in the bath, but it is generally agreed that the use of a solid carburizing agent is preferable when deep case is desired. The cyanide is also very poisonous and potentially dangerous for the workmen. The solid carburizers have as their essential agent solid carbon. All of them generate a carburizing gas at the temperature of carburizing, and it is this gas, not the solid carbon, that is the effective carburizing agent. It has been shown that in the absence of gases, as in a vacuum, solid carbon carburizes only when it is pressed firmly against the iron or steel, and that then its action is is too slow to be of commercial use (ref. 6, 7, 8, 16, 17, 18, 19). Solid carburizers are divided into two groups: 1, those, such as charcoal alone or charcoal with barium carbonate, that carburize almost exclusively by the specific action of carbon monoxide; and, 2, those, such as bone, hide scraps, or ferrocyanide mixtures, that carburize partly through the action of cyanides in addition to the action of carbon monoxide. Those of the second group do not seem to carburize more rapidly than those of the first, but lose their effectiveness much more quickly and are rather more expensive. (Ref. 16, 17, 18, 27.) A mixture of charcoal with 10-40% barium carbonate seems to be the best and most satisfactory of the solid carburizers. The barium carbonate slowly decomposes at the carburizing temperature, yielding barium oxide and carbon dioxide; the latter is reduced by the charcoal to carbon monoxide, and the barium oxide on exposure to air at ordinary temperature is changed back to the carbonate.

$$BaCO_3 \rightarrow BaO + CO_2 \quad \text{at carbonizing temperature}$$
$$CO_2 + C \rightarrow 2\,CO \quad \text{at carbonizing temperature}$$
$$BaO + CO_2 \rightarrow BaCO_3 \quad \text{at ordinary temperature}$$

Calcium carbonate and ammonium carbonate break up too easily, and the alkali carbonates too slowly, to be as good reagents as the barium carbonate.

The nature of the gases evolved on heating some of these solid carburizers is shown in Table I. taken from the de Nolly and Veyret (ref. 18). It is evident that at the higher temperatures the gases are composed almost wholly of hydrogen and carbon monoxide. Nos. 7 and 9 carburized well when fresh, but lost their effectiveness very quickly. Nos. 2 and 3 carburized as rapidly, held their effectiveness longer than the others and seemed to be the most satisfactory. It is well known that the effectiveness of solid

carburizers is usually diminished after several heatings. When first used there is still some destructive distillation with evolution of hydrocarbons as shown in Nos. 1, 2 and 3. After the material has been once heated, as shown in No. 5, the quantity of hydrocarbon decreases and the material assumes more nearly the properties of carbon with added mineral matter.

TABLE I.—*Composition of Gases Evolved on Heating Solid Carburizers.*

Composition of Carburizers—

No. 1-	Wood charcoal.
No. 2-90%	Wood charcoal plus 10% barium carbonate.
No. 3-70%	Wood charcoal plus 30% barium carbonate.
No. 5-	Wood charcoal previously ignited at 1800° F.
No. 7-20%	soot plus 40% Gypsum and 40% potassium ferrocyanide.
No. 9-20%	animal hoof, hide, bone, etc., 50% plant matter, 11% soda, 5% silica brick and 14% moisture.

Analyses of Gases Evolved—

	Sample No.	1	2	3	5	7	9
1560° F.	CO....	11.3	28.1	25.3	42.2	29.4	54.4
	H_2....	74.0	52.8	57.7	20.0	23.6	34.8
	CH_4..	10.0	8.7	8.7	2.0	1.2	1.7
1920° F.	CO....	19.6	37.3	56.1	71.7	55.6	36.8
	H_2....	73.5	60.0	32.0	15.0	19.2	51.4
	CH_4..	0.6	0.9	0,9	0.7	0.9	1.2

Gaseous Carburizers.—The solid carburizers are to be considered merely as agents for generating a carburizing gas whose active constituent is mainly carbon monoxide. Thus the specific action of carbon monoxide greatly preponderates over that of other agents when solid carburizers are used. The solid carburizer is, therefore, unnecessary since the gases may be generated independently, and then conducted into the furnace. There are various advantages in this procedure; the solid carburizers in the carburizing boxes may depreciate or change in composition or action, but by the use of a gaseous carburizer a carburizing agent of uniform quality is assured. We may thus not only maintain a constant composition of the carburizing gas, but we can heat all the pieces in the furnace up to the carburizing temperature before admitting the carburizing gas, and thus carburize all pieces to the same depth. There are three types of gaseous carburizers: 1, carbon monoxide; 2, hydrocarbons; 3, cyanogen, and various volatile organic compounds containing carbon and nitrogen.

Carbon monoxide, when used alone, gives a case low in carbon. At 1,475° F. the case contains 0.80% to 0.90% carbon, but at this temperature the rate of carburization and penetration is very slow. A 2,000° it gives only 0.20–0.30% carbon to the steel, but its rate of penetration is very rapid. Thus carbon monoxide is a poor carburizing agent. At moderately high temperatures it decomposes partially to form carbon dioxide and free carbon, the free carbon combining with the iron. As the temperature increases the decomposition of carbon monoxide into free carbon and carbon dioxide decreases. However, the rate of diffusion of carbon, and also of carbon monoxide, into steel increases when the temperature increases, so that it is quite natural that the percentage of carbon in the case should be lower as the temperature gets higher. In the presence of excess carbon, which may be provided by means of a solid carburized, or by means of a hydrocarbon, the action of carbon monoxide becomes much more satisfactory, and by their combined action a high carbon case may be obtained at high temperature. (Ref. 6, 7, 10, 13, 16, 17, 22).

The hydrocarbons are much stronger carburizers than carbon monoxide, and, if allowed sufficient time, will produce a case very high in carbon. At high temperatures the hydrocarbons decompose, giving as ultimate products carbon and hydrogen. Of the hydrocarbons, methane is the most stable, being practically unchanged when heated to 1,600° F., and even at 1,900° the decomposition is slight, unless accelerated by contact with a porous solid surface. The other hydrocarbons decompose slowly at about 1,500° F., but quite rapidly above 1,700°, and do not require the presence of a contact surface for their decomposition. At relatively low temperatures a large proportion of their decomposition product is methane, but at higher temperatures they decompose directly into carbon and hydrogen. (Ref. 1). The hydrocarbons, when dissociated, deposit carbon on the iron in the form of a scale, and this carbon is probably the means by which they carburize the steel. The carbon from the hydrocarbons, other that methane, is in the form of soot, and when deposited on the surface of a piece is in intimate contact with the iron, and consequently is a very active and rapid carburizing agent. When methane is used, part of it decomposes at the surface of the iron, and leaves a very hard compact scale like retort carbon, but the other part penetrates into the steel until it is eventually decomposed. (Ref. 7). Methane is thus more effective than the other hydrocarbons. A larger portion of the carbon of methane gets into the steel than of the other hydrocarbons, but it acts slowly below 1,700°. (Ref. 7, 7). On the whole, the hydrocarbons are energetic in their action, and produce a case high in carbon, and which increases in carbon content as the temperature of carburizing increases. When pure hydrocarbons are used, the case tends to be too high in carbon and to have too sharp a boundary, and more satisfactory results are attained if they are diluted, so that they do not give a case with so high a carbon content. It has been noted that carbon monoxide gives a case too low in carbon, and that it works better when enriched with a more active carburizer. Thus a mixture a carbon monoxide and hydrocarbon gives the best results. (Ref. 6, 7, 10, 16, 17, 22).

Cyanogen carbonizes very energetically, but gives a case high in carbon, with an abrupt change between the carburized part and the central uncarburized core. The case is thus one easily split off and is not desirable commercially. (Ref. 16 and 17). Free nitrogen has no effect, except to dilute the carburizer and make its action slower. Combined nitrogen, as in ammonia, combines with the iron or steel to give a nitride of iron, that is very hard and exceedingly brittle. Cyanogen is dangerous, because of its extremely poisonous nature, and organic compounds containing nitrogen are somewhat expensive. (Ref. 16, 17, 22). It has been recommended to enrich the carburizer, either solid or gaseous, with sal ammoniac, ammonium carbonate or other ammonium salt, in the belief that ammonia aided in the carburization, probably through the formation of cyanogen. But it has been shown conclusively that the ammonia does not form cyanogen and that it does not help the absorption of carbon. It does make the steel harder through the formation of a nitride of iron, but it is undesirable because of the brittleness of the nitride, as explained above.

Illuminating Gas as a Case-Hardening Agent.—Commercial illuminating gas consists of a mixture of hydrogen and methane, with smaller quantities of other hydrocarbons, carbon monoxide and carbon dioxide. It might be thought that coal gas, which has been formed in a retort at a bright red heat, would not suffer further change at the temperature of the carburizing retort, but such is not the case. The coal gas escapes so rapidly from its retort in the manufacturing process, that it never becomes fully heated to the retort temperature, and when introduced later in a slow stream into the carburizing retort, it breaks down, the hydrocarbons changing to free carbon and hydrogen, and the carbon dioxide and water vapor present reacting to form carbon monoxide and hydrogen. Any coal gas or carburetted water gas will be a strong carburizing agent. (Ref. 10, 16, 27.)

Kurek (ref. 22), gives the results of a number of tests on case-hardening a mild steel by illuminating gas. His steel contained 0.09% carbon and 0.32% manganese, and the gas has the following composition:

	Per Cent.
Carbon dioxide	1.7
Heavy hydrocarbons	2.8
Oxygen	0.3
Carbon monoxide	9.7
Hydrogen	51.7
Methane	30.7
Nitrogen	3 3

He determined the extent to which the carbon had penetrated by removing successive layers of 0.2 mm. each (= 0.008 inches) and analyzing each layer for its carbon content. His results with illuminating gas, methane and carbon monoxide are given in Table II.

TABLE II.—*Results of Case-Hardening with Various Gases, According to Kurek.—Carbon Monoxide.*

Analyses taken from successive layers 0.2 mm. thick.

Temp. Degs. F.	Time.	Per Cent. Carbon in Layer No. 1	2	3	4
1475	8 hours	.67	.32	.28	.21
1650	4 "	.55	.36	.27	.25
1830	4 "	.41	.31	.21	.18
1830	8 "	.46	.36	.36	.29
2000	8 "	.28	.28	.28	.22
1300	4 "	.15	...	...	...
1100	4 "	.13	...	...	...

Methane.

1475	4 hours.....	No carbonizing.			
1650	.....	1.31	.93	.74	.45
1830	.....	1.81	1.41	1.26	.55

Illuminating Gas.

1475	4 hours.....	.93	.35	.16	.13
1650	.....	1.45	1.10	.79	.48
1830	....	2.18	1.37	1.19	.95

The rate at which illuminating gas is conducted through the apparatus affects the carburizing. The hydrocarbons are decomposed gradually, and deposit carbon either as a loose soot or a hard scale on the pieces. The hydrocarbons act mainly at the surface, and by means of this carbon deposit. Therefore, to get the maximum rate there should be a coating of carbon on the surface. As has already been mentioned, carbon monoxide acts most strongly when there is free carbon present, and, for this reason also, there should be a light carbon deposit on the metal. It should, however, be a thin coat if the gases are to have a strong direct action, for if there is a heavy carbon deposit the gases will be partially excluded, and if there is no carbon deposit it indicates either that the hydrocarbons have been decomposed before they came in contact with the steel, or that the carbon is not being deposited on the steel as rapidly as it is absorbed. A practical operating rule would, therefore, be to run the gas into the carburizing chamber at such a rate that there would be a light deposit of carbon on the iron being carburized.

Carbon diffuses into steel very slowly, if at all, below the critical temperature of the steel. Above the critical temperature the diffusion increases quite rapidly as the temperature increases. All the carburizers, except carbon monoxide, produce a greater per cent. of carbon in the carburized zone as the temperature increases. The following table showing the effect of temperature is taken from Robin. (Ref. 26.) The original steel contained 0.03% carbon.

TABLE III.—*Results of Carburizing Low Carbon Steel for Seven Hours in Illuminating Gas at Various Temperatures, According to Robin.*

	Per Cent. Carbon at Depth of				
Temp.	1 mm.	2 mm.	3 mm	4 mm.	5 mm
1112° F.....	0.051	0.032			
1292.....	0.096	0.045	0.036		
1472.....	0.21	0.105	0.048		
1652.....	0.363	0.21	0.057	0.03	
1742	0.451	0.219	0.093	0.049	
1832.....	0.579	0.321	0.241	0.152	0.091
1922.....	0.594	0.365	0.322	0.212	0.15
2012.....	1.522	1.487	1.284	1.147	0.988
2102.....	1.637	1.604	1.382	1.330	1.195
2192.....	2.364	1.708	1.488	1.437	1.349

The figures in the first column up to 2012° may seem low, but it is to be noted that this analysis is not at the surface but at a depth of 1 mm. from the surface. The original steel contained only 0.03% carbon, and not about 0.20% as is usually used for case-hardening.

The concentration of a carburizer may be defined as the quantity acting on each surface unit of the metal in unit time. The concentration of a gaseous carburizing agent may be changed by diluting it with an inactive gas or by changing the gaseous pressure. It is not generally desirable to dilute the carburizers, as this simply makes carburizing slower, but it would sometimes be desirable to increase the rate of carburizing by concentrating the carburizers, i. e., by using them under pressure. Carbon monoxide responds quite appreciably to increase in pressure, but other gaseous carburizers do not. This can be explained as follows: The equilibrium of chemical reactions tends to change, so that a reaction will tend to relieve the conditions that produce the change. If the pressure is increased, the reaction will tend to proceed in a direction to relieve the pressure; that is in such a direction as will cause a decrease in volume.

$$2\,CO \rightarrow CO_2 + C$$
2 Vol. 1 Vol.

$$CH_4 \rightarrow C + 2H_2$$
1 Vol. 2 Vol.

$$C_2H_6 \rightarrow 2C + 3H_2$$
1 Vol. 3 Vol.

A glance at these equations will show that the decomposition of carbon monoxide into carbon dioxide reduces the volume to one-half the original, while in the other two reactions the desomposition that will produce carbon causes an increase in volume. Consequently the carbon monoxide will carbonize faster under high than under low pressure. At 0.6 atmosphere the hydrocarbons carbonize very little slower than at atmospheric pressure, while the carbon monoxide carburazises only about 0.7 times as fast. (Ref. 7).

The depth of carburization increases with its duration, and for about two hours the rate of penetration is nearly proportional to the duration, but as the time becomes longer the rate of penetration becomes slower. This is due to the fact the carburizers introduce carbon into the surface layers faster than diffusion carries the carbide of iron into the iron. Thus the layers of the surface will be carburized rapidly by the direct action of the carburizer, while the deeper layers will be carburized mainly by the diffusion of carbon or carbide through the steel. Illuminating gas at about 1,750° will give a case 1/32 inch in thickness in 3 hours.

Experimental Work.—There is some disagreement among the authorities cited as to the value of illuminating gas as a case-hardening agent, and the conditions under which it should be used, so experiments were conducted on a laboratory scale, with as much care as possible, to add further data for discussion.

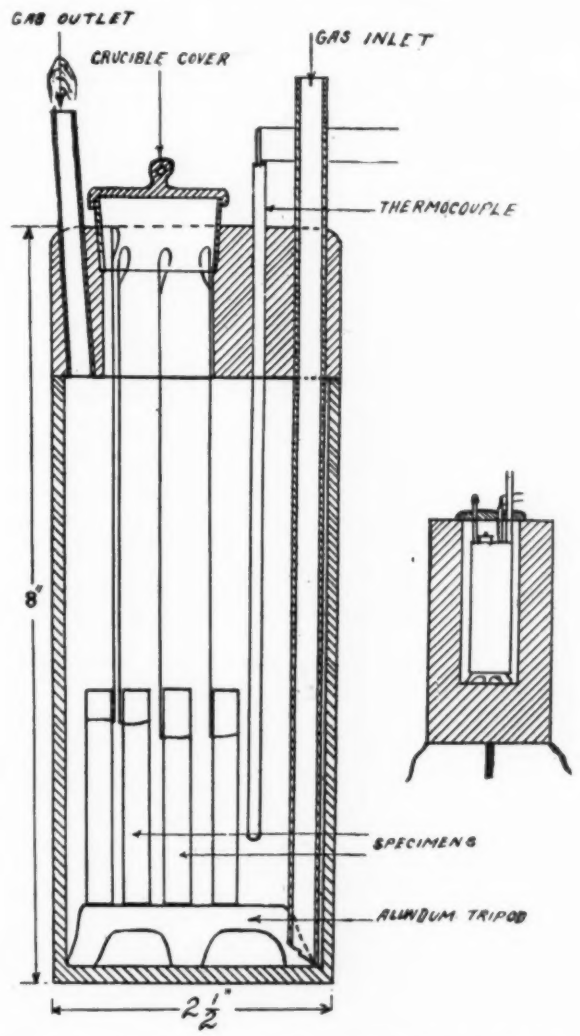

Plate I.—Laboratory Furnace for Case-Hardening Steel with Illuminating Gas.

The construction of the laboratory curburizing furnace is shown in Plate I. An unglazed porcelain cup formed the body of the muffle. The top was built up of alundum cement, with the inlet, outlet, and thermocouple tubes inserted. The upper part of a porcelain crucible was sawed off and inserted to form the charging hole, and the crucible cover was used as the cover. In the bottom of the muffle was placed an alundum table. The specimens, which were about $\frac{3}{8}$" square and 2½" long, were lowered into the muffle on wires, and stood on end on this table, so that the gas was spread out and diffused evenly in the lower part of the furnace, and all pieces were exposed on all four sides to the gas and at the

same temperature. This muffle was placed within a vertical electric muffle furnace, that could be heated very evenly and kept within 5° of any desired temperature for a long time. In commencing a test, the furnace was heated about 75° higher than the desired temperature. The current was then reduced to a value that would just maintain the furnace at the desired temperature, and the specimens put in. The excess heat in the furnace counterbalanced the cooling effect, and the furnace and contents could in this way be brought to the desired temperature in about 15 minutes. After being carburized for the proper length of time, the specimens were lifted out by means of wires, and buried in charcoal, where they were allowed to cool. The charcoal was to prevent the pieces from being decarburized by the oxygen of the air. The wires used for supports for lifting out of the muffle were, after carburizing, so hard that considerable force was required to bend them. Their hardness was similar to that of piano wire, but they were much more easily broken. In the test where ammonia was used, those wires were not as strong, only a slight force was required to bend them, and only a slight deflection was required to break them. The gas used for carburizing was an unenriched coal gas with a heating value of 600-620 B. T. U. The gas was passed in at a rate to barely maintain a plus pressure in the muffle.

By running several different steels at the same time the effect of the composition of the steel could be determined; by running pieces from the same bar for the same length of time, but at different temperatures, the influence of temperature could be determined; by running pieces of steel of the same composition, for the same length of time and at the same temperature, but with a different quality or composition of gas, the effect of the composition of the gas could be found. The results agreed well among themselves, and confirmed the results of previous workers who found illuminating gas a desirable carburizing agent.

The change in composition of the carburized pieces was determined by the usual microscopic methods. The slowly cooled pieces were sawed in two, and the sections thus made polished and etched for about half a minute in 2% alcoholic nitric acid. By this method, the ferrite, or almost pure uncombined iron, is etched very little on a short immersion and appears white. The pearlite, which contains between 0.85% and 0.90% carbon appears almost black, since it is etched deeply and unevenly. Cementite, which contains 6.67% carbon, appears white like the ferrite, but can be distinguished from the ferrite in the photographs, since it appears in the form of needles or a fine white network against a background of black pearlite. The ferrite is much coarser and appears as white crystals with a boundary of black pearlite. The ferrite will be found in the inside of the specimen which, in these illustrations, is always at the left hand side; while the cementite, if present, is on the outside, and the pearlite is between the two.

TABLE IV.—*Composition of Steel Used in Case-Hardening Tests.*

	Mild Steel.	Machine Steel.	Nickel-Chrome Steel
Carbon	0.04%	0.22	0.354
Manganese	0.10	0.44	0.486
Phosphorus	0.007	0.011	0.012
Sulphur	0.029	0.031	0.026
Silicon	.....	.....	0.162
Nickel	.....	.....	1.50
Chromium	.....	.....	0.57

The composition of the steels used is given in Table IV. Tests were run at 1650°, 1740°, 1830° and 1920° F., with pure coal gas; and at 1650° with coal gas containing about 6% of gaseous ammonia. One series of tests was run with a uniform carburizing period of 3 hours. Since a 3 hour treatment at 1850–1950° gives a case higher in carbon and also rather deeper than is usually required, three more tests were run of shorter duration. One set of pieces was kept exactly 1 hour in the furnace, with carburizing gas on during the whole run and the temperature ranging from 1830° at the end of 10 minutes to 1740° at end of the hour. The other two were both of 1 hour and 10 minutes duration, and the temperature ranged from 1900° at the end of 10 minutes to 1975° at the end of the run. The carburizing gas was turned on at the end of 10 minutes and turned off at the end of 40 minutes. Thus the carburizing gas was on 30 minutes and the piece was allowed to soak 30 minutes at the high temperature, thus giving the high carbon near the surface opportunity to diffuse deeper into the piece.

After the test pieces had been cooled in charcoal, a portion was sawed off for misroscopic examination and the remaining portion subjected to the double heat treatment usually given case-hardened work.

TABLE V.—*Results of Carburization in Coal Gas.*

Designation.	Depth of case in inches: Total.	Less than 0.85 per cent. C.	0.85-0.90 per cent. C.	Greater than 0.90 per cent. C.	Hardness after quenching. Brinell number.
Carburized for 3 Hours at 1650° F.					
0.04% C	0.024	0.014	0.010	....	285
0.22% C	0.028	0.012	0.016	....	445
Ni-Cr	0.030	0.010	0.020	....	555
Carburized for 3 Hours at 1740° F.					
0.22% C	.035	.016	.015	.003	555
0.22% C*	.032	.023	.012	....	555
Ni-Cr	.040	.016	.024	....	601
Carburized for 3 House at 1830° F.					
0.22% C	.048	.014	.012	.012	601
Ni-Cr	.072	.020	.052	....	653
Carburized for 3 Hours at 1920° F.					
0.04% C	.055	.016	.914	.025	601
0.22% C	.084	.033	.020	.031	627
Ni-Cr	.092	.023	.052	.017	601
Carburized for 3 Hours at 1650° F., with Coal Gas plus 6% Ammonia.					
0.04% C	.030	.026	doubtful composition be-		321
0.22% C	.030	.024	cause of nitride of iron		477
Ni-Cr	.028	....			601
Carburized for 30 Minutes at 1900°–1975° in Coal Gas and then Allowed to Soak 30 Minutes.					
0.04% C	.030	.01	.02	....	...
0.22% C	.045	.02	.025	....	...
Carburized for 1 Hour at 1830°–1740° in Coal Gas.					
0.22% C	.02	.01	.01	....	...

* Protected by a wrapping of asbestos.

Results of Experimental Work in Case-Hardening With Coal Gas.—The experimental work showed that practically any desired type of case could be readily obtained. The results of a number of different tests made at various temperatures, and with differing conditions, are given in Table V., and shown in part in the series of photomicrographs forming Plates 2 and 3. The depth to which the carbon had penetrated was determined by microscopic observation, and the carburized area was further divided in the same manner into the hypo-eutectoid area with less than 0.85% carbon, the eutectoid area with 0.85-0.90% carbon and the hyper-eutectoid area with more than 0.90% carbon. After preparing the sections for the microscope, the remainder of the sections were subjected to the ordinary double heat treatment for hardening. They were heated to 1650° F., about fifteen minutes being required to bring them to this temperature, and then quenched in oil. Then they were reheated to 1475° F., and quenched in water at a temperature of 60° F. The hardness was then determined by the Brinell test.

The effect of varying temperatures in the three hour carburizing test is best shown in the photomicrographs of Plate II. Fig. 1 shows the results of carburizing the machine steel (0.22% carbon) for three hours at 1650° F. The magnification in all of the figures is twenty-four diameters. The black region at the right of Fig. 1 shows the depth to which the carbon penetrated. The total depth carburized is 0.028 inches, and of this, 0.016 inch is of approximately the eutectoid composition (0.85-0.90% carbon). The remaining 0.014 inch of the case diminishes in carbon content to the normal 0.22% of the untreated steel. Fig. 2 shows the result of carburizing the steel for the same length of time at a temperature nearly one hundred degrees higher (1740° F.). The readily apparent difference is that the case is nearly 50% thicker than that formed at the lower temperature. Careful observation also shows on the extreme right hand edge, a thin layer of hyper-eutectoid composition (above 0.90% carbon). Fig. 3 is inserted to show the futility of trying to protect the metal from the carburizing gas by wrapping it with asbestos. When the bar shown in Fig. 2 was carburized, its upper half was wrapped closely with asbestos paper until the wrapping was about 3/32 of an inch thick. The effect of higher temperature (1830° F.) is shown in Fig. 4. Not only is the total depth of case greater, but the per cent. of carbon in the outer layers has increased markedly, as shown by the needles of cemen-

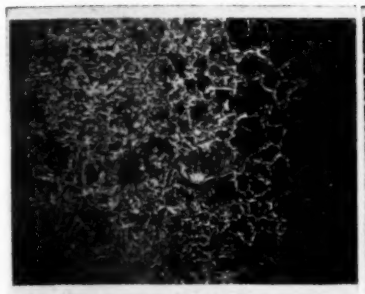

FIG 1. Carburized 3 hrs. at 1650° F.

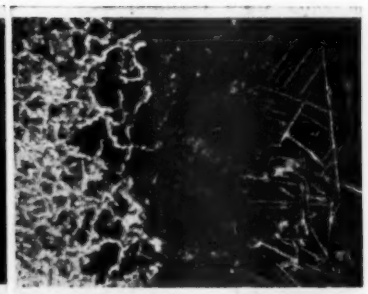

FIG. 4. Carburized 3 hrs. at 1830°F.

FIG. 2. Carburized 3 hrs. at 1740°F.

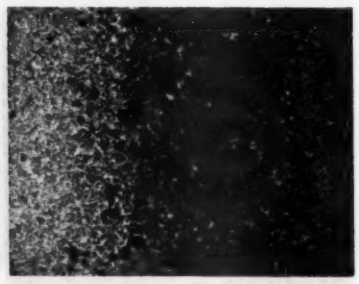

FIG. 5. Duplicate of FIG. 4 but Heat Treated to refine grain.

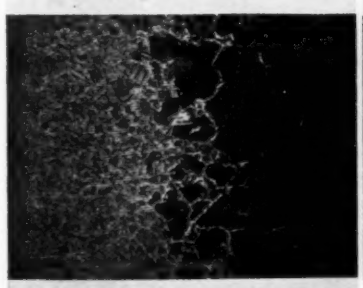

FIG. 3. Carburized 3 hrs. at 1740° F. but protected with Asbestos.

FIG. 6. Carburized 3 hrs. at 1920°F.

Plate II.—Photomicrograph of Specimens of Steel with 0.22 per cent. Carbon Case-Hardened in Illuminating Gas. Magnification 24 Diameters.

tite (carbide of iron) in the right hand portion of the field. Fig. 5 is a section of this same test piece, after it has had its grain refined by a double heat treatment conducted as follows: The test piece No. 4 was heated in a neutral atmosphere to 1625° F., ten minutes being required for the operation, and was then slowly cooled in charcoal. It was then put back in the furnace and reheated to 1475°, and again slowly cooled. The resultant fine grained piece shown in Fig. 5 is much less brittle than the coarse grained Fig. 4. Fig. 6 shows the result of carburizing for three hours at 1920° F. At this temperature the absorption of carbon has been so rapid that the case, after three hours carburizing, is too high in carbon for the best results.

The figures in Plate II. showed the effect of treating one steel (0.22% carbon) with coal gas at differing temperatures, for three hours. Those on Plate III. give some illustrations of the results when different steels are used, and the treatment varied. The specimen shown in Fig. 7 was heated for three hours in coal gas at 1920° F., as was No. 6. The steel initially used contained, however, only 0.04% of carbon instead of 0.22%. The piece has apparently taken up carbon of about the same rate as the higher carbon steel, and the finished material is about as much lower in carbon as would have been expected from the initial composition of the steels.

Fig. 8 presents several points of difference. The steel used was the chrome-nickel steel, whose composition has been given, carburized three hours at 1,650° F., in an atmosphere of coal gas to which had been added about 6% of gaseous ammonia. The chrome-nickel steel carbonizes very much as the plain carbon steel shown in Fig. I. The added ammonia has caused, however, the formation of a nitride of iron, which appears as a rather granular white constituent on the right hand edge of tho piece. The addition of ammonia or ammonium compounds to carburizing agents has been

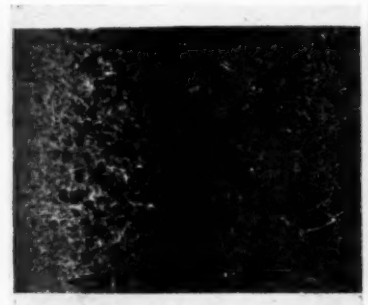

FIG. 7. Steel with 0.04% Carbon Carburized 3 hrs. at 1920°F.

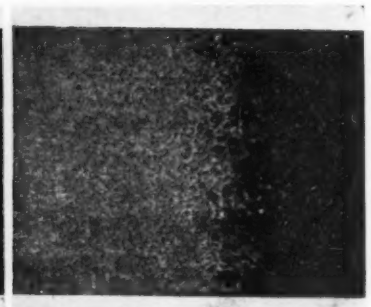

FIG. 9. Steel with 0.04% Carbon Carburized for 30 min. at 1900-1975°F. in Coal Gas and then allowed to soak in furnace for 30 min.

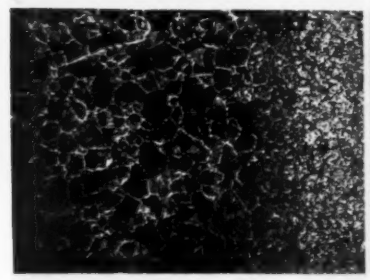

FIG. 8. Chrome-Nickel Steel Carburized 3 hrs. at 1650°F. in Illuminating Gas with 6% NH_3 added.

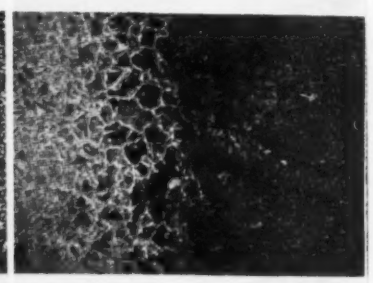

FIG. 10. Steel with 0.22% Carbon treated as FIG. 9.

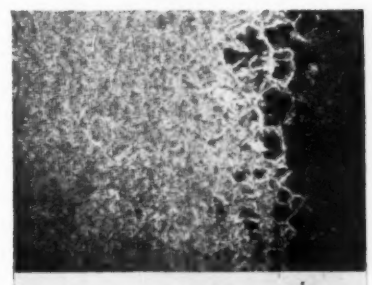

FIG. 11. Steel with 0.22 % Carbon Carburized for 1 hr. at 1830-1740°F.

Plate III.—Photomicrograph of Specimen of Steel Carburized with Coal Gas. Magnification 24 Diameters.

advocated on the ground that a hard case is more rapidly obtained, but this practice is objectionable, for the nitrate of iron, although hard, is very brittle. This was shown by the wires attached to the test pieces while they were being carburized. The wire on the specimen carburized in gas with added ammonia was scarcely stronger than a straw, while in the experiments where gas alone was used, these wires possessed a strength and hardiness similar to an ordinary cambric needle.

Rapid Carburizing with Gas.—It has already been pointed out that not only does the rate of carburizing increase rapidly with the temperature, but that the percentage of carbon in the case increases also. Too high a percentage of carbon is objectionable, and Giolitti's objection to illuminating gas as a carburizing agent is largely based upon this difficulty. If the skin is too high in carbon, and there is not a gradual gradation in carbon content from the outside to the inside of the case, there may be such a difference of expansion that in extreme cases, the case-hardened skin may split off on quenching. Giolitti, therefore, prefers as a case-hardening agent, carbon monoxide, which works more slowly and uniformly. A modification in the treatment with illuminating gas, which is here described, has, however, remedied the difficulties usually experienced in using illuminating gas at high temperatures.

The procedure adopted was to place the test pieces in the retort, and carburize with coal gas for a short time at a high temperature, producing a thin case high in carbon. The carburizing gas was then shut off, and the steel left to soak in the hot retort until the ab-

(Continued on page 266)

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NEW YORK, MONDAY, OCTOBER 25, 1915.

Gas Chemistry.

A "Bibliography of the Chemistry of Gas Manufacture" has just been issued by the United States Bureau of Mines, as Technical Paper 120, the authors being W. F. Rittman and M. C. Whitaker.

The references listed are selected from a much larger number gathered by the authors during several years research work on problems dealing with the chemical behavior of hydrocarbons. It is not an attempt to cover every phase of gas manufacture, the object being to present a bibliography of carefully chosen references dealing with the chemistry of gas making, and the chemical changes involved in the production of combustible gases. In view of the fact that there is no other published bibliography of this subject, the list, with the cross reference idex, is published by the Bureau in the hope that it will be utilized as a guide for investigators, chemists, engineers, and operators of gas plants. Copies of the paper may be had by addressing the Director of the Bureau of Mines, Washington, D. C.

A Safe Business.

An analysis of 6,237 employee accidents reported by 119 gas companies in 35 States to the Accident Prevention Committee of the American Gas Institute, shows the following:

	Per cent.
Leak of gas, inside	1.62
Leak of gas, outside (3 fatalities)	1.03
Animal bites	1.75
Machinery in normal operation (1 fatality)	2.63
Elevators (2 fatalities)	2.19
Explosions, ignited gas, etc. (3 fatalities)	3.01
Falling in or through openings (1 fatility)	4.23
Hot material (1 fatality)	4.88
Objects, hanging or swinging	.75
Objects, protruding	4.36
Objects falling (1 fatality)	11.29
Flying particles	7.87
Vehicles (3 fatalities)	8.69
Nails, wires, etc.	6.53
Handling of material	9.73
Slipping or tripping	8.93
Hand tools used by injured	12.80
Hand tools used by fellow employee	2.19
Miscellaneous (1 fatality)	5.52
	100.00

It will be noted that accidents peculiar to the gas industry are among the lowest percentages; the greatest menaces being falling objects, handling material, and hand tools used by the injured, all of which are common to other industries, and preventable with a little care and common sense. The first year's experience of the Utilities Mutual Insurance Company bears out these conclusions, the damages which it has had to pay being but 16% of the premiums collected from the member companies. It would undoubtedly pay the industry as a whole to carry its own accident liability, as most of Empire State gas and electric companies are doing through the Mutual Company.

Bombarding Gas Works.

According to an account in the "Journal des Usines á Gaz," the first gas works affected in the present war, was that at Mulhouse, where fighting took place in the gas works itself early in August, 1914, and on the night of the 9th the gas holders were severely damaged by shrapnel and ball. The shell of the holders were pierced, the gas escaping without taking fire, and when the firing was over repairs were easily made. The other parts of the plant suffered little, except for three breaks in yard mains. Repairs were made so rapidly that the supply of gas was interrupted for only 24 hours for one part of the town, and 48 for another. At Rheims, on June 15th last, 111 shells had fallen on the gas works. All parts of the plant had suffered, the principal damage being to the exhauster and station meter house, the purifying house and the holders. The five holders had been struck by nine shells, many of them of large size. Generally the shells burst immediately as they struck the holder, but none of them directly fired the gas. In one holder, as gas was escaping through holes made by shells, another shell exploded near the holder and ignited the gas, which burned at all the holes in the holder. The bell sank steadily, and the flames died down without producing an explosion. At Münster, Upper Alsace, a hole 5 feet long was made in the holder, and the contents escaped without producing an explosion. During the night a patch was put on and the work finished before dawn. At a works in Flanders, probably Ypres, the holder was struck by a number of shells, wrecking the guides framing and making holes nearly 7 feet in diameter in the steel tank.

The conciusions are that the mains do not seem to suffer when they are at a sufficient depth. When shells fall on a paved road little damage is done underground, since the shells explode on the hard surface and do not penetrate the soil. Shells which pierce a holder do not kindle the gas. Shells bursting on the holder do not kindle the gas, probably because the sudden development of large quantities of inert gas at high pressure has the effect of driving back the coal gas, and the explosion-flame has passed off before the gas can come in contact with it.

How To Get Business.

The original preacher of the "public-be-pleased" policy, Henry L. Doherty, has this to say about new business:

"Monopoly business is the kind that the public utility gets whether its patrons like it or not; and only that much. In other words, it is the very least amount of business the public can give it.

"The old school of public-utility purveyors thought this was all the business that could possibly be secured.

"The new school knows there is a world of business that is not monopoly business.

"It is *good-will* business.

"Good-will means more business, more profits, less trouble, and more happiness.

"Depend for patronage upon good service, square dealing and the friendship of the patrons.

"This lesson, once learned, is not soon forgotten.

"It pays even when judged from a dollar and cents standpoint alone.

"But better still, it pays a 'dividend in human happiness' that no rate-making body can take away from you."

American Association of Engineers.

Plans for the National Convention of the American Association of Engineers, to be held in Chicago, Dec. 10 and 11, are being rapidly completed. All engineering societies have been invited to send official representatives to the convention, to join in the discussion and assist in attempts to solve a few of the welfare problems confronting the enginner.

A National Membership Committee has been selected to push the organization of local chapters. Those on the committee are, A. H. Krom, Assistant Engineer, Illinois State Public Utilities Commission; F H. Newell, Professor of Civil Engineering, University of Illinois; S. Steenerson, Engineer Minnesota Highway Commission, Crookston, Minn.; Edwin R. Webster, Civil Engineer, Marion, Ia.. Daniel B. Luten, Bridge Engineer, Indianapolis, Ind.; O. L. Dent, Referee in Drainage Matters, Bemidji, Minn.; R. A. West, Civil Engineer, Tye River, Va.; Israel L. Beerman, Engineer, N. Y. State Highway Commission, Filmore, N. Y.; Harold Almert, Consulting Engineer, Chicago, Ills.; W. N. Winter, Electrical Engineer, Hood River, Ore.; H. L. Holderman, Civil Engineer, C. M. & St. P. Ry., Lewistown, Mont.; Ernest McCullough, Consulting Engineer, Chicago, Ills.; George E. Keech, Electrical Engineer, Chicago; A. T. North, Contracting Engineer, Chicago.

Owing to the increase in its activities, the Association has taken larger quarters at 29 S. La Salle Street, Chicago.

Supervision of the work of the Qualification Committee has been undertaken by Ernest McCullough, Consulting Engineer, Chicago. The Service Clearing House is actively engaged in putting the engineer in touch with the employer, and employers in touch with men without charges. One of the largest electrical manufacturing companies in the United States has given the Association preference in filling all vacancies that require men technically trained.

National Safety Congress.

The National Safety Council, the nation-wide organization for the prevention of accidents in the industries, on the railroads and in public places, held its fourth annual safety congress at the Bellevue-Stratford Hotel, Philadelphia, October 19 to 21, inclusive. One of the features of the meeting was the simultaneous sectional meetings on Wednesday and Thursday, October 20 and 21, some of them of the informal round table sort. These separate sessions were for the cement industry, for the laundry, for mining, for paper manufacturing, for public utilities, for railroads (this section having a program taking all day Wednesday and all of Thursday morning), for the textile industry, for medical supervision and care of employees, for safeguarding machinery, for the foundry and for woodworking plants.

The opening session of the congress was held on Tuesday, Oct. 19, at 10 A. M., R. W. Campbell, Illinois Steel Company, president of the National Safety Council, presiding. This session was occupied largely with reports of officers and committees, including those of the standardization of safety devices committee, the industrial hygiene committee, the accident statistics committee, the danger signs committee and the fire prevention committee.

On Tuesday afternoon a general session was held, under the chairmanship of John Price Jackson, commissioner of labor and industry of Pennsylvania.

Illuminating Engineering Society Council.

A meeting of the Council of the Illuminating Engineering Society was held October 14, in the general offices of the Society, 29 West 39th street, New York.

After considering the appointments to various committees for the present year, preliminary plans were discused for a semi-annual convention in New York next February, to mark the 10th anniversary of the organization of the Society.

It was also planned to arrange for a course of lectures on illuminating engineering, similar to the course given in the Fall of 1910, at the Johns Hopkins University, under the auspices of the Society. The programs of papers and meetings for the various sections of the Society were read and discussed briefly by the vice-presidents representing the sections. Those present at the meeting were President Charles P. Steinmetz, H. Calvert, Wm. A. Durgin, Clarence L. Law, M. Luckiesh, A. S. McAllister, L. B. Marks, J. Arnold Norcross and G. H. Stickney.

Annual Meeting, Manufacturers' Section, N. C. G. A.

An important meeting of a growing and influential branch of the Gas Fraternity, was held at the McAlpin Hotel, New York City, on the evening of October 19th. Thirty-five members were present. It was the annual meeting of the Manufacturers' section of the N. C. G. A., under the direction of President W. M. Crane, assisted by Secretary Will W. Barnes. Various routine matters were taken care of, the most important being the election of officers as follows:

President, R. K. Clark.
First Vice-President, W. G. Gribbel.
Second Vice-President, L. B. Young.
Secretary, Will W. Barnes.
Treasurer, C. W. Wardell.

A report on the Washington Gas Show, which is under direction of the section, showed that all but four spaces have been sold and alloted.

New York Gas Meeters—Business Meeting.

The first meeting of the New York Section Gas Meeters, held on the evening of October 21st, at the Hotel Breslin, New York City, was devoted to business. Chairman C. E. Chapple called for expressions of opinion regarding the kind of entertainment which would do most to interest gas men in the metropolitan district. The concensus of opinion seems to be that the former method of visiting places of interest should be adopted. Announcement was made that during the show at Washington a Gas Meeters dinner would be held. Among those present entering into the discussion were Messrs. Barnes, Brock, Berg, Bullard, Owens, Gerlich, MacArthur, Siani and Welland.

Philadelphia Gas Meeters, October Meeting.

Profiting by experience, the Philadelphia Gas Meeters have decided to hold only four or five dinners during the coming winter, and make them events rather than incidents. We quote from the notice of Mr. W. G. Murfit, Secretary. The opening dinner of the season will be he held Thursday, October 28th, on the Roof Garden of the Hotel Adelphia, Philadelphia, Pa. It will be a Hallowe'en Beef Steak Dinner. This occasion has only to compare favorably with occasions of the past to be well worth while. Mr. Murfit's address is 1038 Cherry street, Philadelphia. Let him know that you will attend.

Another Section of Gas Meeters Organized.

A new section of the Gas Meeters was organized at Akron, O., Saturday, October 16th, 1915.

Just 50 men were present to help organize this body, and the election of officers resulted in the selection as Chairman of Commissioners of Mr. L. B. Terry, Agent, The East Ohio Gas Company, Akron, O., the other two commissioners being A. J. Quinlan and Phillip Lewis. The Secretary-Treasurer selected was Mr. W. A. Strauss, also of the East Ohio Gas Company, at Akron, O.

At the request of one of the members, Mr. F. R. Hutchinson, Grand Commissioner of Gas Meeters, was selected as temporary chairman to conduct the election and talk to members of the new section, at some length on the spirit of good fellowship provided through gas men joining the Gas Meeters.

The Akron section will consist of members from Akron, Canton, Cuyahoga Falls, Kent, Ravenna, Barberton. Woodsworth, Doylestown, Wooster, Massillion, Canal Dover, New Philadelphia and Dennison, O.

(*Continued from page 263.*)

sorbed carbon had diffused itself through a deeper area, and the case was of the quality desired. The specimens shown in Figs. 9 and 10 were carburized in this manner at 1,900° F., in a total time of 1 hour and 10 minutes. It required 10 minutes to bring the specimens to the furnace temperature; the coal gas was then passed slowly in for 30 minutes, and then turned off; the pieces remaining in the furnace for another 30 minutes to allow diffusion of the carbon toward the center of the piece. Neither of these pieces show the high carbon hyper-eutectoid layer, which had been an objectionable feature of all attemps to accelerate case-hardening by the use of hydrocarbons at high temperatures. Sample No. 9, originally of 0.04% carbon, shows a total carburized depth of 0.030", of which the outer two-thirds has approximately the eutectoid composition. Sample No. 10, originally of 0.22% carbon, is carburized somewhat more deeply. Neither piece shows an objectionably high carbon centent in the outer skin, nor a sudden line of demarcation between the curburized and uncarburized area. The amount of time saved by working at the higher temperature may be seen from a comparison of Figs. 10 and 11. The same steel was used in both cases, and the time of heating was 1 hour in each case. Sample No. 10 was heated at 1,900° F. for an hour, although it was exposed to the gas only half that time. Sample No. 11 was started in a furnace at 1,830° F., but the temperature dropped during the hour to 1,740° F., the carburizing gas passing through the retort the whole time. As may be seen from the photomicrograph, the thickness of the carburized area in No. 11 is less than half that in No. 10. More exact figure of the tests on these various steels are given in Table V.

Summary.—As soon as it was shown that the action of solid carburizers was due primarily to gases that they evolved, and that the deterioration of solid carburizers in practice was due to the emission of these gases, it at once became evident that the use of a gaseous carburizer of proper composition offered the greatest possibility for accurate control of the process. Illuminating gas, either coal or carburetted water gas, is a good carburizing agent and has been used successfully in a number of commercial installations. It has, however, been claimed that it gives too hard and sharply marked a case if an attempt is made to carburize rapidly at high temperature. This paper shows that by case-hardening at a high temperature for a relatively short time, and then turning off the carburizing gas and allowing the hot metal to soak in the furnace, there will be diffusion of the carbon toward the interior of the piece and any desired type of case can be obtained. The use of ammonia in case-hardening is not recommended since a brittle nitride of iron results.

The commercial aspects of case-hardening with gas cannot be treated in this paper. It seems, however, quite evident from the data presented here and in the accompanying paper on "The Heat Treatment of Steel in a Neutral Atmosphere," that it will be possible to work out a commercial process whereby the pieces are placed in the furnace, heated in a neutral atmosphere, carburized in gas of controlled composition and kept hot in an atmosphere of neutral gas until the desired diffusion of the carbon has been obtained. The pieces must, of course, be removed from the furnace for quenching, but will be heated again in an atmosphere of neutral or perhaps slightly carburizing gas for their final heat treatments.

BIBLIOGRAPHY.

Arranged in Chronological Order.

1. Bone and Coward Thermal Decomposition of Hydrocarbons.
   Jour., Chem. Soc. Vol. 93 (1) p. 1197. (1908).
2. Springer. Gaseous Carbonizing with Gasoline Producer Gas.
   Iron Age, Vol. 81, p. 1688.
3. Richards and Fay. Care-hardening Locomotive Bearings.
   Railroad Age Gazette, Vol. 45, p. 162.
4. Olsen and Weiffenback. Some Exp. on Case-hardening Steel with Gases.
   Chemical Engineer, Vol. 10, p. 60 (1909).
5. Guillet and Griffiths. The Cementation of Iron by Carbon in Vacuum.
   Compt. Rend., Vol. 149, p. 125.
   Chem. Abs., 1910, p. 2434.
6. Giolitti and Carnevali. The Preparation of Cementation Steel, II.
   Gas. Chim. Ital., Vol. 38 (2), p. 309.
   Chem. Abs., 1910, p. 3060.
7. A. Portevin. Sur La Cementation par les Gas.
   Revue Metal, Memoires, Vol. 7, p. 859. (1910.)
   Chem. Abs., 1911, p. 1731.
8. Weyl. Metallurgie, Vol. 7, p. 440.
   Chem, Abs., 1911, p. 1393.
9. Giolitti and Tavanti. Invest. Concern. Preparation of Cementation Steel, III. The Phenomenon of Liquation.
   Gas. Chim. Ital., Vol. 39 (2), p. 386.
   Chem. Abs., 1911, p. 273.
10. Giolitti and Astorri. Invest. Concern. Prep. Cementation Steel, IV. The Specific Function of Gaseous and Solid Cementing Agents in Cementation.
   Gas. Chim. Ital., Vol. 40 (1), p. 1.
   Revue Metal, Vol. 7, p. 876. (1910.)
   Chem. Abs., 1911, p. 274.
11. Giolitti and Carnevali. Investigations Concerning the Preparation of Cementation Steel, V.
   Atti. accad. sci. Torino., vol. 45, Feb. 1910.
   Revue Metal, Vol. 7 (1910), p. 881.
   Chems. Abs., 1911, p. 275.
12. Giolitti and Carnevali. Investigations Concerning the Preparation of Cementation Steel, VI.
   Atti. accad. sci. Torino., Vol. 45, Feb. 1910.
   Chem. Zentr., Vol 2 (1910), p. 923.
   Chem. Abs., 1911, p. 275.
13. Giolitti and Tavanti. Investigations Concerning the Preparation of Cementation Steel, VII.
   Atti. accad. sci. Torino., Nol. 45, Mar. 1910.
   Chem. Zentr. (1910), vol. 2, p. 924.
   Chem. Abs., 1911, p. 275.
14. Lake. Composition and Heat Treatment of Steel, p. 227.
15. Giolitti and Carneveli. Case-Hardening by means of Compressed Gases.
   Jour. Iron and Steel Inst., Vol. 84 (2), p. 331, (1911).
16. Giolitti. New Industrial Process for Case-Hardening Steel.
   Jour. Iron and Steel Inst., Vol. 84 (2), p. 307 (1911).
17. Giolitti. State of our Knowledge Regarding Cementation.
   Rass. Min., 1912, pp. 101, 125, 141.
   Stahl und Eisen, 1912 (1), p. 199.
18. deNolly and Veyret. Etude Sur Les Gaz Degages per les Cements.
   Revue de Metallurgie (Memoires), vol. 9 (1912), p. 53.
   Stahl und Eisen, 1912 (2), p. 1581.
19. Charpy and Bannerot. Cementation of Iron by Solid Carbon.
   Compt. Rend., Vol. 153, p. 671.
   Chem. Abs., 1912, p. 209.
20. Baume and Basadonna. Research s. l. Cementation p. l. Gaz. et l. Melanges Gazeux.
   Arch. Sci. Phy. & Nat., Vol. 34, p. 349 (1912, July-Dec.)
21. A. Sauveur. Cementation and Case-Hardening of Steel. Metallography of Iron and Steel. Lesson 16.
22. Kurek. Beitrage zur Kenntnis der Zementation des Eisen mittels Gasen.
   Stahl und Eisen, Vol. 32, p. 1780 (1912) (2).
   Chem. Abstracts, 1913, p. 465.
23. Sauveur and Reinhardt. Note on the Case-Hardening of Special Steels.
   Bull. Am. Inst. Mining Eng., Vol. 71, p. 1335.
   Chem. Abs., 1913, p. 582.
24. Abbott. Notes on Case-Hardening of Special Steels.
   Bull. Am. Inst. Min. Eng., Vol, 72, p. 1563.
   Chem. Abs., 1913, p. 1159.
25. Abbott. Action of Various Carbonizing Materials.
   Bull. Am. Inst. Mining Eng., Vol. 72, p. 1407.
   Chem. Abs., 1913, p. 962.
26. Robin. Revue de Mecanique. Nov., 1913.
   Gas World, Jan. 1914, p. 44.
27. Portevin. Cementation of Steel with Mixed Hardening Agents.
   Mem. Soc. Ing. Civ. France. Vol. 66, p. 347.
   Chem. Abs., 1914, p. 1258.
28. Thomas. Hardness of Metals.
   Eng. News, Vol. 72, p. 179.
29. Guillet and Bernard. Reserves in Cementation and Diflusion in Solids.
   Bull. Soc. Encour. ind. nat., Vol. 121, p. 588–618.
   Chemical Abstracts, 1914, p. 3000.
30. Giolitti. The Cementation of Iron and Steel. A book in which Giolitti reviews all his previous articles on cementation. Probably the best book written which treats of the subject from the scientific standpoint.

Industrial Fuel.

Paper by F. W. FRUEAUFF, to the International Gas Congress.

The application of gas to industrial uses began when the Bunsen burner was perfected. Little progress was made until less than 20 years ago, when manufacturers began building appliances especially designed for gas fuel. Since that time wonderful strides have been made in perfecting burners, and in bringing out well designed appliances to meet the requirements of different industries; until to-day there is an appliance on the market for almost every industrial fuel purpose, except where very large furnaces are required.

In the early stages of this work, and to a large extent at present, the sale of gas for industrial uses depended upon the characteristics peculiar to gas fuel—its adaptability, cleanliness, ease of heat regulation, etc., as well as its freedom from the objectionable features of the other fuels, namely, dirt, ashes, storage room, required handling, etc. The industries in which these advantages were sufficient to overcome the difference in cost between gas and the other fuels, were the ones in which gas was first marketed. These industries comprise restaurants, hotels, bakeries, candy manufacturers, etc. The adaptability of gas to a varying demand makes its use quite general in certain industries where a small amount of heat is required, intermittently, in such operations as soldering, brazing, etc.

It is only recently that gas companies have come to appreciate the fact that gas is the most desirable fuel for all furnace work, and the important question before us is, what are the difficulties that are hindering the attainment of so great a goal? Generally speaking, the obstacles met are as follows:

First.—The apparent difficulty of establishing rates that will make it possible to secure this business. No doubt the most feasible method is to manufacture a less expensive gas, that will meet the fuel requirements of the industries and can be sold at a lower price than is now possible.

Second.—A shortage of well trained industrial fuel engineers—men who combine the engineer's abililty to solve fuel problems, with the salesman's ability to sell.

Third.—A lack of efficient large appliances to meet the needs of the large fuel users.

Rates for Industrial Gas.—The question of lower rates for large gas consumption has been discussed very often, yet no general action has been taken by gas companies. Companies that have adopted a sliding scale or readiness-to-serve rates, have had large increases in consumption from fields that were formerly impossible to exploit.

The indurtrial fuel business is wholesale business, and can only be conducted according to the principles underlying wholesale transactions. It is analogous to the electric power business, in which wholesale rates combined with well-trained commercial engineers, have been productive of large and profitable returns to the companies.

In cities where a straight meter rate for gas is in effect, a handicap, amounting almost to a penalty, is put on the use of gas for industrial purposes.

Industrial Fuel Gas.—It is not within the scope of this report to discuss means of manufacturing a less expensive fuel to be distributed to industries at a lower price than is customary. However, it is highly important to appreciate the enormous field open to gas companies whenever it becomes possible to offer such a fuel.

No doubt, State and municipal legislation regarding candle power and heat value has greatly handicapped the development of the industrial fuel business in the past, but changes from present standards must come in the near future, because they will be equally beneficial to consumers and to the companies.

Industrial Salesmen.—Apparently there is not enough incentive to attract young engineers to industrial fuel work, and as a result, the number of men engaged in this branch of the industry is relatively small, and but a few of them have had proper training to equip them for the work.

The men who usually enter this field are taken from the New Business Departments, where they have shown ability to sell domestic appliances. Without the necessary engineering training they are handicapped, and when difficult problems arise, a condition always recurring in industrial work, they fail to solve the problems correctly, and the installations they make are frequently taken out. The mistakes made by industrial men in one city have often seriously affected propositions in other cities where similar industries are located. The industrial field is responsible for a good part of the increases in output of gas companies, and since the future of the industry depends to no small extent upon the development of this branch, it is of utmost importance that men are developed who have the necessary training to secure and retain large industrial gas consumptions.

Industrial Appliances.—As previously stated, great progress has been made in the development of appliances using gas fuel. However, there still remain many opportunities for improvements in them.

A manufacturer using fuel appliances in his factory is desirous of securing one result—the lowest net cost of production regardless of what fuel is used. Even if lower gas rates for large consumption become general in the near future, they cannot be made low enough to compete with other fuels on a thermal basis only. There will still remain a considerable difference in cost between gas and other fuels when the fuel costs alone are considered. To overcome this difference it is necessary to have very efficient gas appliances, in order to increase the output per appliance, to lower the labor cost per unit of production, and to produce a superior article. Having accomplished this, the other advantages of gas fuel will receive credit, and the net costs with gas can then be proven to be much lower than the net costs with other fuels.

The perfecting of appliances is therefore essential. More progress has been made in developing appliances for hotels, restaurants, bakeries and candy manufacturers, than with large industrial appliances. This is a natural result, because a greater number of hotel appliances are sold than of the large industrial appliances.

Manufacturers of large industrial appliances are probably justified in being somewhat reluctant to spend money for further developing such appliances, because they are necessarily special and but few of any one design can be sold, and since the bulk of the costs are engineering and not manufacturing, the builder must charge a rather large price for these appliances. The only way of overcoming this condition appears to lie in the establishing of a central developing bureau, to be supported by gas companies for the purpose of solving large and complex industrial problems, as well as developing and perfecting furnaces. No doubt, if furnaces were built embodying the principles of air preheating or heat recuperation, higher efficiencies could be secured, and consumptions obtained that cannot be had with the present appliances.

The amount of gas used for industrial purposes is, after all, but a small fraction of the total industrial fuel used for furnace work in this country. Fuel oil, valued at millions of dollars per year, is used; a by-product of crude oil frequently subjected to wide fluctuation in price. Gas is the logical fuel for manufacturers to adopt for permanent use.

To reap the benefits of this wholesale business, gas companies must therefore bring about the following conditions:

First.—Lower rates for large comsumptions; and if possible from a public policy standpoint, the producing of a gas that can be made and distributed at a much less cost than that now supplied.

Second.—More thoroughly trained men; who must receive a remuneration in keeping with the knowledge required and the results secured.

Third.—The establishing of a central developing bureau to assist gas companies in solving difficult propositions, so that large consumptions can be taken on.

Electrically Removing Tar from Gas.

F. W. Steere, of Detroit, Mich., has taken out three patents as Assignor to the Semet-Solvay Company, for removing tarry substances from gas. According to the first patent, the gas is passed through an electrical field of alternating polarity, between receiving and discharging electrodes, and is subjected to the action of brush electric discharges from a discharging electrode that has a pointed surface. The tarry particles coalesce, and are deposited on the receiving electrode. By the second patent, the particles of tar are agglomerated as just described, and are subsequently separated, the gas being passed at such a high velocity that the particles are removed from the electric field with the gas. In the third case the gas is heated sufficiently to liquefy the tar and raise the gas above its water vapor saturation temperature, and is then passed through an electric field of alternating polarity between opposed electrodes. According to a French patent taken out by H. F. Smith, the gas is passed through a diaphragm of glass wool at such a speed that the fibers are electrified. The very small particles are attracted to the fibers, or are carried through and coalesce into larger drops—being then removed by another filter. Large particles which are retained are removed by the gas stream on reversing the diaphragm.

Electrolysis Mitigation.

The Technical Paper of the Bureau of Standards on this subject gives a general discussion of electrolysis, comprising a comparison of conditions in America with those in other countries, a discussion of electrolytic corrosion proper, as distinguished from self-corrosion, and touches briefly on electrolysis effects in concrete and steel buildings. There is also a brief discussion of other effects of stray currents, such, for example, as the production of fires and explosions.

All of the various methods of mitigation that have been proposed or tried are discussed, under two main heads: First, those applicable to underground pipe and cable systems; and, second, those applicable to the railway negative return. Methods applicable to underground pipe systems comprise the following: (1) Surface insulation of the pipes; (2) chemical protection—that is, rendering the pipe surface passive by surrounding it with earth filled with lime or other chemicals that will prevent corrosion; (3) cement coatings; (4) cathodic protection—that is, maintaining the pipe or cable always negative to earth by means of battery or other sources of electromotive force; (5) favorable location of pipe with respect to tracks; (6) the use of non-corrodible conducting coatings; (7) electric screens; (8) insulating joints in pipes; and (9) pipe drainage.

The conclusion is that none of the various methods tried are suitable for general use as primary means of preventing electrolysis. Chemical protection, cement coatings, cathodic protection, and conducting coatings must be regarded as substantially worthless in their present state of development. Surface insulation of pipes by paints or dips is not much more reliable; but insulation by putting pipes in troughs or conduits filled with pitch, may be used in special cases, where the expense is justified. The practice of placing pipes as far as possible from railway tracks affords a certain measure of protection, of which advantage should always be taken when laying new lines or relaying old ones. The use of electric screens is often a valuable expedient in taking care of acute local cases of trouble in existing mains.

Pipe drainage is sometimes useful, but should be used with proper restriction, and precautions against setting up dangerous conditions, either in the system drained or in neighboring systems. In general, in city networks, where there are a number of independent underground systems to be protected, pipe drainage should be used as little as possible, and chief reliance placed on measures applied to railway negative return. The drainage of lead cable systems, will, however, usually be desirable, if by insulated feeder systems, arranged to drain the least practicable current from the cables, in order that neighboring structures may not be subjected to unnecessary danger.

The most valuable mitigative measure that can be applied to a pipe system is the proper use of insulating joints; and the extensive use of such joints should be encouraged. Precautions necessary in their use are set forth in the discussion.

Taking up the methods applicable to the railway system, there is brief reference to the alternating current system, double-trolley system, the use of negative trolley, and the periodic reversal of trolley polarity. This is followed by more extended discussion of methods of reducing potential differences in the uninsulated portion of the negative return. These means comprise: (1) Proper construction and maintenance of way; (2) grounding of tracks and negative bus; (3) use of uninsulated negative feeders; (4) use of insulated negative feeders without boosters; (5) use of insulated negative feeders with boosters; (6) three-wire systems; and (7) proper number and location of power houses.

The discussion leads to the conclusion that the alternating-current system, the double-trolley system, the use of negative trolley, the periodic reversal of trolley polarity, and the use of uninsulated negative feeders in parallel with the rails, when considered only as methods of electrolysis mitigation, are either impracticable, or the expense or operating difficulties attending their application are unnecessary, because there are other adequate methods available, comparatively cheap to install, and which introduce but slight complications into the operating system.

The importance of proper construction and maintenance of track return is emphasized, and the drainage of the roadbed is urged. Where the track is on private right of way it should be kept as far as possible from direct contact with the earth, by use of good rock ballast.

It is also pointed out that the three-wire system, from the standpoint of electrolysis mitigation, possesses large possibilities, but that up to the present sufficient experience has not been had to determine whether it is practicable from the operating standpoint.

The most effective methods that have been thoroughly tried out are the use of insulated negative feeders, with and without boosters. Where the feeding distances are not too long, an insulated feeder system without boosters will prove cheapest and most satisfactory, because of its simplicity. It is possible, by the proper application of such systems, to reduce the potential gradients in the earth to such low values that little damage will result. In many cases, however, it may be better to combine one of these methods with either the insertion of a moderate number of insulating joints in the pipes, or with the use of a very limited amount of pipe drainage, provided local conditions are favorable. The insulated feeder system would be applied to reduce the potential gradients throughout the system, and one or the other of the auxiliary systems used to eliminate residual electrolysis that might still remain.

The last section of the paper is devoted to regulations regarding electrolysis mitigation. What criteria should be used for determining electrolysis conditions is taken up at some length. Potential measurements showing the drop in the railway negative return, and potential gradient measurements throughout the track network are very valuable. All-day average values of these potential readings give a better criterion of the danger from electrolysis than any short-time peak value. It is recommended that in fixing voltage limitations some plan analogous to the zone system should be adopted, the voltage limits prescribed for the various zones determined by the degree of development of the underground utilities in them. The voltage drops either in the tracks or in the pipes, and earth may be used as the basis for fixing limitations, but in general the latter is to be preferred. The conclusion is reached that for the overall potential drop in tracks, a limit of from two to four volts is reasonable and adequate, and the potential gradient should in general be restricted to 0.3 or 0.4 per thousand feet, these being all-day average values. Where short-time peak values are used, the figures would, of course, be considerably higher.

In order that the ready determination of voltage drops may be made, potential wires should be installed from some central point to selected points on the railway or pipe networks. These points should include the points of approximately highest and lowest potential, and some intermediate points. It is recommended that exemption from regulations regarding track voltages should be made in special cases where local conditions make it improbable that any serious damage would result. The responsibilities of the owners of underground utilities regarding the mitigation of electrolysis troubles is discussed, and it is recommended that any regulations should apply not only to the railway system, but should also define the responsibilities of the owners of underground utilities, since the latter can often contribute materially to the diminution of the trouble.

The Difference between English and German Refractory Materials.

By ALFRED B. SEARLE, in Journal of the Royal Society of Arts.

The successful way in which the Germans have developed the manufacture of various heat-resisting materials, has been demonstrated by the war, and as time goes on the absence of supplies becomes more and more trying to industries requiring heat-resisting materials. The manufacture of chemical porcelain, for instance, is almost unknown in Great Britain, and we now have to depend for supplies obtained more or less surreptitiously, through neutral countries such as Holland and Scandinavia. This encourages a number of British potters to make some simple attempts at the manufacture of refractory porcelain, but though they could make ware that would withstand acid, they could not produce a porcelain with the insensitiveness to sudden changes in temperature so characteristic of the Saxon ware. Other experiments are being made, and it is hoped that before long this ware, so important to chemists, will be successfully manufactured in this country at prices not markedly higher than have been paid for imported material. Meanwhile, the use of fused silica ware or "vitreosil" is increasing, as it meets all the requirements, but is more costly than porcelain.

The importation of firebrick for coke ovens and furnaces, from Belgium and other parts of the Continent, has ceased during the war. Firebricks of equal refractoriness can be had in this country, but they do not satisfy the tests that Continental builders of ovens consider essential. British firebrick manufacturers are making extensive efforts to overcome the objections, and are gradually increasing their ability to make firebricks to fit any reasonable specification. They have much to learn, however, though they have

made rapid progress since the war began. Firebricks for furnaces and similar purposes where the specifications are less stringent can be made successfully in this country, though the prices of firebricks in extra-European countries before the war were largely in favor of those made in Germany. This was due to the much larger works working on a system of "dumping" that does not appeal to British manufacturers. It is curious that with inferior materials to those commonly used in Great Britain, the Germans turn out better firebricks, and have been able to guarantee results that British firms find impracticable. With competition less severe, British manufacturers are now turning their attention to improving the qualities of their goods, as in the past they concentrated on the production of cheap brick. With adequate technical assistance of a kind not generally available, they will be able to make great improvements in quality, and should, in time, be able to produce better brick than any now on the market.

Retorts for the manufacture of coal gas cannot be imported from Germany, so gas engineers are compelled to use the home-made products. There is much divergence of opinion as to the relative values of British and German retorts, and it has not been unusual to find German engineers importing British retorts, whilst some British engineers preferred to purchase German ones. Here again British manufacturers are trying to meet the demands as far as they are able.

The chief difference between British and German refractory materials may be traced to the difference in the ownership and management of the firms. In this country refractory materials are chiefly made by men who have worked themselves up from a small beginning—or the descendants of such men—their chief characteristic being that of a workmen whose knowledge and experience have been gained almost entirely in the workshop, and whose theoretical knowledge—either of chemistry, physics or mechanics—is almost negligible. The German manufacturers of refractory materials, on the contrary, have almost invariably had a sound training in chemistry and engineering; they approach the manufacture from an entirely different point of view—namely, that of the user turned manufacturer. Consequently they are more impressed with the needs of the user, whilst the British manufacturer is chiefly impressed with the difficulties of manufacture and the limitations imposed by his material. If once this basis could be overcome—and the only remedy is the better education of the manufacturers—there is no question that better refractory goods can be made in Great Britain than can be obtained from the Continent for the same price.

Recent Patent Issues.

Prepared for the AMERICAN GAS LIGHT JOURNAL by ROYAL E. BURNHAM, solicitor of patents and counselor in patent causes, 833 Bond Building, Washington, D. C., from whom illustrations and specifications of any patent mentioned below may be obtained for 20 cents.

1,150,166. Gas Burner. F. E. Brown, Boston, Mass.

1,150,333–4. Gas Stove and Water Heater. J. Brauninger, Trenton, N. J.

1,150,454. Apparatus for Recovering Hydrocarbon Products from Gas. A. E. Roberts, San Francisco, Cal.

1,150,666. Gas Heater. F. E. Doerr, Portsmouth, O.

1,150,759. Gas Controller. D. B. Grubb and H. B. Butler, Birmingham, England.

1,150,807–8–9–10. Retort Furnace. H. A. Carpenter, Sewickley, Pa., assignor to Riter-Conley Mfg. Co., Pittsburgh, Pa.

1,150,998. Gas Heater. O. E. Chaney, Steubenville, O., assignor of one-half to P. Loretta, same place.

1,151,108. Operating Device for Gas Stoves. J. E. Kennedy, Washington, D. C.

1,151,304. Safety Lock for Gas Valves. M. J. Svoboda, Chicago, Ills.

1,151,327. Gas Burner Igniter. F. Andreas, St. Louis, Mo.

1,151,342. Manufacture of Inverted Mantles. S. Cohn, New York City, assignor to Mantle Machinery & Patents Co., same place.

1,151,514. Gas Main Stopper. J. S. Donohue, Washington, D. C., assignor of one-third to J. E. Moreland, and one-third to M. V. Moran, same place.

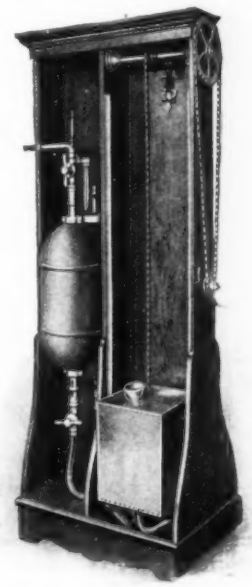
1,151,575. Gas Heating Radiator. G. Duchscherer, Buffalo, N. Y.

1,151,579. Mantle Threading Machine. E. E. Flora and J. F. Murphy, Chicago, Ills., assignors, by mesne assignments, to Mantle Machinery and Patents Co., New York City.

1,151,676. Process of Generating Steam Accessory to the Production of Producer Gas. H. Foersterling, Perth Amboy, N. J., assignor to Roessler and Hasslacher Chemical Co.

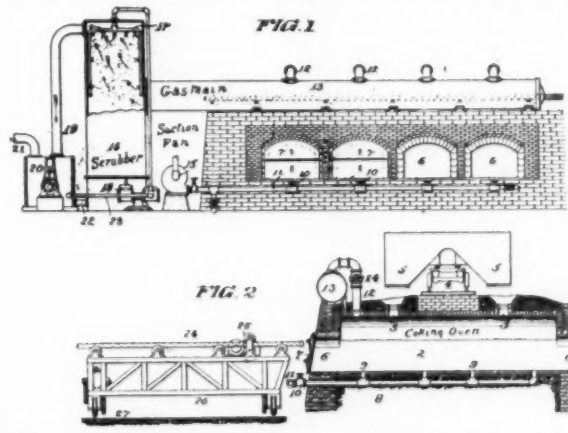
New Methods and Appliances.

FOR TESTING THE TESTING.—The new style cubic foot bottle made by the American Meter Company, embodies all the accuracy of the cabinet type, and operates as easily and simply as the immersion



type, and is cleaner in every respect. The cut indicates the ease of operation; the copper water band is raised and lowered by the crank and sprocket wheels, and there is no splashing or dropping of water.

BEE-HIVE RECOVERY OVENS.—Coal is charged into the oven 2, and combustion started at the bottom assisted by a blast from the tuyères 9. The vents 3 are closed and the valves 14 are opened. The gases distilled from the coal are drawn off by suction in the main 13, and pass through the scrubber or cooling tower 16, where they are subjected to the action of sprays of sulphate liquor. The gas is then passed into the suction rotary washer 20, where the ammonia not already absorbed in the tower 16, is taken up by sulphate liquor and the purified gas passed to a suitable holder.



In the distillation of the coal the volatile constituents are delivered into a common space within the oven above the coal and the suction, by means of which such constituents are drawn off, is applied to this common space whereby substantial concentration of the blast upon particular portions of the coal is avoided. The suction is continued until the coal becomes fully heated from the bottom to the top. The suction is then shut off until the coking of the coal is completed.

SOME FACTS ABOUT LIMESTONE.—A ton of absolutely pure limestone would burn to a little over half its weight of lime, or about 1,120 pounds, which counting 80 pounds to a bushel, would give 14 bushels of lime to a ton. The weight of the burned product, however, generally averages more than this, owing to impurities in the limestone and also because in ordinary kilns the combustion is not complete enough to drive off all the carbon dioxide.

A cubic foot of limestone averages in weight from 145 to 175 pounds, which would make a ton of limestone contain from 11 to 14 cubic feet.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. FERD. JOSEPH SCHLOTT, died Oct. 4, at the age of 87 years. He was born May 28, 1828, in Fulda, Germany, where he received his education and learned the trade of silversmith. Mr. Schlott came to America in 1849, and shortly afterward procured a position with the American Meter Company, afterwards being made Superintendent, which position he held until 1902, when he retired, having given faithful service for 50 years.

THE Trustees of Columbia University have established a Department of Chemical Engineering upon the same plane of importance in the Columbia Graduate Engineering School as the Mining, Civil, Electrical and Mechanical Departments. The head of the new department in M. C. Whitaker, who has been Professor of Chemical Engineering at Columbia for five years. The new chemical-engineering laboratories, recently installed, are equipped with apparatus to illustrate the various fundamental operations of chemical and electro-chemical processes, and to apply fundamental principles to industrial problems. Research may be conducted here on such a scale as to establish the dependable engineering data necessary for intelligent and accurate process design. Registration in the new department reached a total of 81 during the past year.

OWING to the prohibitive rates of money exchange, the Brazilian Traction, Light and Power Company, Ltd., found itself unable to remit money from Brazil for the payment of coupons and dividends, and the board of directors decided to remit its funds in coffee. As the Rio de Janeiro Tramway, Light and Power Company, a subsidiary, has under charter a fleet of steamers, carrying the coal and other material required by the company's subsidiaries in Rio de Janeiro and Sao Paulo, these steamers on their retuan journeys carried coffee, purchased in Brazil, to the New York and European markets. Since coffee is a staple product in commerce, it offered a safe, and at the same time the only practical, means of remitting the company's funds. Up to tue end of the year they purchased and shipped from Rio de Janeiro and Santos, 278,400 bags of coffee, to the value of 11,695,000,000 reis, or more than $6,000,000, all of which has been disposed of in New York at prices that enabled the company to net an average of 27.7 cents per milreis, which is materially in excess of the average rate of exchange during the period.

FROM Jan. 1 to June 15, inclusive, the Detroit City Gas Company received 3,874 service applications, installed or being installed, a gain of 341 over the corresponding period of 1914, when the total applications were 3,533. Beginning with 1900, when the 7,428 service connections were installed, the company made its best record in 1913, with 9,892 installations. The year 1914 showed a decrease, 8,559 service connections being installed. There is no better indication of the steady expansion of Detroit among industries, stores and residences than in the statistics showing consistent increase in the growth of public utilities.

TWO important propositions have been made to the town of Hull, Mass., which are creating considerable discussion. One is the proposal of an electric light concern to purchase the municipal electrical lighting plant at Whitehead. For at least two decades it has been an open question whether the plant was a financial benefit to the town. If the town can obtain a satisfactory price for the plant, and a contract to furnish current for a less price than the town can produce it, it is argued that the sale of the plant would be the proper course. The second proposition is the introduction of gas, for which the Summer folks are clamoring.

THE standardizing of gas and electrical appliances among Doherty Organization properties will be considered by a committee comprising: Chairman, F. J. Petura, purchasing agent at the New York offices; George Williams, general manager of the New Business Department; F. C. Weber, New York engineering staff; C. H. Merritt, general manager of the Danbury and Bethel Gas and Electric Light Company; Harry D. Frueauff, general manager of the City Light and Traction Company, Sedalia, Mo.; Clare N. Stannard, secretary of the Denver Gas and Electric Light Company, and A. K. Young, New Business Manager of the Toledo Railways and Light Company.

THE inspection of the quality of gas furnished to the people of Ottawa, Ill., as made by F. C. Johnson, inspector of weights and measures, speaks highly for the gas company. He made his initial inspection September 27th. The gas ordinance calls for 600 B. T. U., and Mr. Johnson's findings exceed that. The readings made were as follows: September 27th, 627; September 28th, 626; September, 30th, 616; October 2d, 603.

A TEN cent reduction in gas price is probable for Lincoln, Ill., as a rate agreement reached by the City of Lincoln and the Logan County Gas Company has gone to the State Public Utilities Commission for ratification. The proposed rate is: $1.40 per 1,000 feet, gross. $1.25 net; no bill to be rendered for less than 35 cents. The present rate calls for $1.50 per 1,000 feet gross; $1.40 net, for lighting, and $1.25 net, for fuel.

DR. A. H. ELLIOTT, who repoted the Gas Congress and the American Gas Institute meetings for the JOURNAL, acted as representative of the Institution of Gas Engineers, and cabled reports of the sessions to London.

AT the annual meeting of the Consolidated Gas, Electric Light and Power Company, of Baltimore, Howard Bruce and Siegmund B. Sonneborn of Baltimore, Morton Otis of London, England, and Frank M. Taft of New York, associated with the N. F. Brady interests, were elected new directors. Other directors were re-elected. Former officers were re-elected and Charles E. F. Clarke was elected an additional vice-president.

HILLSDALE, Mich., is discussing the purchase of the Hillsdale Gas Company. Under the franchise granted the company on July 10, 1899, to run for 30 years, the city, after 15 years, can, if it desires, purchase the plant of the company. The agreement specifies that in arriving at a fair price for purchase the board of arbitration shall not take into consideration the value of the franchise, but shall allow a fair value for the property actually used, and shall take into consideration as an element of the value the earning capacity of the property and business as then existing.

ROBERT YOUNG, for the past nine years Superintendent of the Sheboygan (Wis.) Gas Light Company, has resigned to enter private business at Pittsburgh, Pa., and the company, in appreciation of Mr. Young's services, has retained him in an advisory capacity at full salary until Jan. 1. On that day Mr. Young will be succeeded by H. W. Easterly, from Green Bay.

THE Old Colony Gas Company, Weymouth, Mass., for the month ending September 30, 1915, reports a send-out of 7,642,000 cubic feet, as compared with an output for the same month of the previous year of 6,305,000 cubic feet, an increase of 21.2%.

THE City of Chicago has petitioned the courts to have $10,000,000 now in the treasury of the People's Gas Light and Coke Company impounded, on the grounds that this money rightfully belongs to the Chicago consumers of gas. It represents the difference between rates fixed by the city ordinance in 1911 and the charge made by the gas company during the last four years.

EDWARD G. CLEMINSON has been appointed auditor for the Citizens' Gas and Electric Company in the general office in Omaha. The appointment brings with it a very large responsibility and, of course, a correspondingly increased salary. Mr. Cleminson has served the company in the Council Bluffs offices for thirteen years, of late as cashier. Howard Butler, formerly of Council Bluffs, now employed in the accounting department in the Omaha offices, will succeed Mr. Cleminson as cashier.

THE Selectmen of Mansfield, Mass., have granted a franchise to the Taunton Gas Company to do business in Mansfield. Some weeks ago a petition was received from a Mansfield gas company then forming, and while the Selectmen were investigating the merits of the latter, the Taunton company put in an application. The Selectmen also received a petition from the Norwood Gas Company, but it was refused.

THE New Haven (Conn.) Gas Light Company has made its quarterly distribution of stock to its employees, under the profit shar-

ing plan, allotting 111 shares, of the value of $4,273, to 323 employees, who are participating. At present there are 1,863 shares outstanding among the employees of the company, of the value of $72,000.

SINCE the consolidation of the East Boston and Chelsea, Mass., companies, under the name of the East Boston Gas Company, and the establishment of a commercial department, the business has increased so much that it is necessary to secure more room. Conditions at the East Boston office making it necessary to seek new quarters, the company has signed a 20-year lease for the store and basement at 38 Central square, formerly occupied by the post office, and has remodeled the premises, making a roomy and up-to-date office, where the wants of customers can be taken care of with convenience and celerity. The clerical force has been transferred to the new office, and the collectors and meter readers will make their headquarters there. The Chelsea office will be renovated and remodeled, and will be headquarters for the commercial department, under Mr. Joseph M. Riley, manager.

MANAGER A. ABBOTT LAUGHTON, of the Gardner (Mass.) Gas, Fuel and Light Company, entertained the members of the Gas and Electric Association at his home on Woodland avenue, a couple of weeks ago. After the dinner and business meeting, during which George T. Mills, of Athol, was elected president, there was an informal entertainment, in which Arthur Sanschagrin, Mr. Mills and A. W. Evans, Jr., of Orange, played a prominent part. Among those present were G. T. Mills, G. C. McKnight, J. V. McDonald, Andrew Mann, L. E. Martin, E. S. French, Albert M. McDonald, Harold McDonald, Fred Compton and John Twitchell, Athol; L. C. Bryant, Harry Robbins, James Burke, Ernest Horton and A. W. Evans, Jr., Orange; L. B. Hartshorn, Wendell; E. R. Rummery, Westminster; C. A. Farrington, East Templeton; J. F. Leamy, Hiram Helman, Arthur Sanschagrin, William H. Heathfield, R. B. Smith, F. L. Gilson, William Ronayne, William Kemp, Michael Lackewz and Solin Oakes, Gardner.

THE Pacific Gas and Electric Company, after informal conference with the Commission, has re-established the monthly minimum charge of 50 cents for gas in San Francisco, which was in effect until July 1. Shortly after that date the company increased its minimum to 85 cents. The matter was taken up with the commissian, and the company now advises that it will refund all amounts collected in excess of 50 cents since July 1. The total is about $4,000. The former scale was $1 for each meter larger than ten lights and 50 cents for a meter of less capacity. The company altered this to 85 cents for all meters.

AT the last meeting of the Portland (Me.) Gas Meeters Captain Bud Carey of the U. S. Aviation Corps, who has been performing feats in aviation in Portland, gave an interesting talk on aviation. Mayor William M. Ingraham was one of the club's guests, and gave a short talk at the close of the meeting. There was a musical entertainment, and among the invited guests present were Hon. William M. Ingraham, Capt. Bud Carey, P. Paffen, Frank J. Mitchell, Francis D. Martin, Edward Nolan, Elmer Sawyer, Isaac Haines, Thomas J. Silke, Geo. W. Fisher and Capt. Carey's mechanician, Charles Grieder.

IT is said that the French Government intend to make denatured alcohol a State monopoly, beginning in 1917, and that the use of alcohol as a motor fuel will be encouraged. It is assumed that the government will place denatured alcohol on the market at a lower price than either benzol or gasoline; and this will probably have an important effect upon the production and prices of benzol.

ILLUMINATION for the homes of the future from the luciferous substance carried by fire-flies, certain other insects, fish and animals, was predicted by Dr. Ulric Dahlgren, Prefessor of Biology at Princeton University, in a lecture at the Franklin Institute, in Philadelphia. Dr. Dahlgren said that he believes this substance is of an altogether chemical composition. "Once the nature and proportions of these chemicals are discovered," he added, "the light extraordinary for commercial purposes will follow. It will render 99% of efficiency, where the lights of to-day can only produce 15%."

UTILITIES COMMISSION NEWS.

BONDS IN SINKING FUND EXEMPT.—An opinion handed down by the State Tax Commission of Maryland in the case of the Baltimore Trust Company against the Appeal Tax Court of Baltimore city, holds that its own bonds in a sinking fund of a company are not taxable.

The Trust Company has held, as trustee under a mortgage of the Annapolis Gas and Electric Company, $28,000 of the company's bonds in its sinking fund. The Appeal Tax Court assessed them The Commission says that they were not taxable.

BOSTON SLIDING SCALE.—The Massachusetts Commission gave a hearing on September 30 on the status of the sliding-scale agreement between the State and the Boston Consolidated Gas Company, anticipating a report to the Legislature upon the desirability of continuing the agreement for another ten years. President J. L. Richards of the company appeared before the board and explained that under the agreement dividends have been increased, while the price has dropped from $1 to 80 cents per 1000 cubic feet, and $420,000 has been paid to employees through a profit-sharing system. The cost of manufacture has been reduced from 57.11 cents per 1000 cubic feet in 1906 to 49.11 cents in 1915. He said that the company could not reduce the price to 70 or 75 cents and maintain the dividends allowed by law. The board will consider whether the scale should be applied to other cities besides Boston. L. W. E. Kimball of the Independent Brotherhood of Electrical Workers, Boston, opposed the sliding scale.

COLORADO UTILITY COMMISSIONER ON WEAKNESS OF MUNICIPAL OWNERSHIP.—S. S. Kimball, Chairman of the Colorado Utilities Commission, in a recent address, said: "It is a notorious fact that very few towns have the slightest conception as to what it is costing them to build, operate and maintain a plant; possibly in some instances they don't care, but as a plain business proposition they should know whether a plant is self-sustaining, or is maintained by general taxation. Under a proper system of accounting, they would be compelled to segrate all items of income and disbursements that properly belong to a plant, from other departments, and will be required to set aside annually from their revenues, a reserve fund to cover depreciation.

"While this is done in most cases for privately owned plants, it is seldom, if ever, done in the case of municipal owned plants. It is only natural that city officials should want to make as good a showing as possible, and they are only too willing to allow their successors to assume the burden of renewals to the property. The result is that in a few years not much value is left to the plant, except as junk."

MUST OWN PHYSICAL PROPERTY.—The city of Neenah complained to the commission that the rates of the Wisconsin Traction, Light, Heat and Power Company were unreasonable, the immediate remedy sought, however, being not a reduction in rates, but to put into effect a plan by which the city proposed to purchase from the respondent all of the current used for any purpose within the city of Neenah, and to resell the same to the individual consumers, passing on to the latter, the advantage of the low rate per kilowatt hour that the city expected to secure through purchasing on an accumulative basis. According to the city's plan, the company, if a satisfactory contract could be entered into, was to relinquish its claim to its present consumers and refrain thereafter from selling at retail within the city, and the city was to obligate itself to buy current from the respondent for a term of ten years.

The commission held that the right to do a public utility business is contingent upon the ownership of the physical property, and that such right is itself property; that if the city acquires the right to sell directly to the consuming public at Neenah, it takes something of value from respondent; that under the Public Utilities Law a municipality can only terminate a franchise or indeterminate permit by determining to acquire the plant of the public utility and paying just compensation for the property as a going concern; that it is not possible for the city to acquire the business of the respondent without purchasing all of the property used and useful for the convenience of the public involved, and that the arrangement in question, if lawful, would not be desirable, since the supposed economics would not follow.

Financial Notes.

THE 5-point net rise of CONSOLIDATED GAS in one day to the highest price in nearly five years, indicated the feelings of speculators in advance of the dividend meeting. Melon talk was in the air, as it had been frequently before, and with as much, and no more, of a basis than last year or the year before, although it has been known for a long time that the directors were considering ways for distributing a part of the company's assets to shareholders. Stockholders thought that a start was made six months ago, when extra quarterly payments of 1% were ordered. This was to make up to shareowners the income they did not get in the interval when 4% annually was paid, before the rate returned to 6%. The total of these payments amounts to about 27%, and one phase of expectation is that the whole amount may be paid off in the near future, either in cash or script. Another is that assets in securities owned by the company may be distributed. The directors make no comment on the rumors. It is difficult to consider Consolidated Gas as a war stock, but intimations have of late been made the company had entered into contracts for the sale of by-products, to be used in munition manufacture, which were proving very profitable. A director was quoted as saying that this story was merely one of the many accompanying the rise of the stock, Just the same, a gain of more than 21 points in a fortnight add something of a war stock atmosphere to gas.

THE GRAND RAPIDS GAS LIGHT COMPANY has filed at Lansing notice of increase in capitallzation from $2,000,000 to $3,500,000.

THE PACIFIC GAS AND ELECTRIC COMPANY has advanced the subscription price on the unsold portion of its new 6% first preferred stock to 87½. There is something over $1,000,000 of the $12,500,000 of this issue unsold, and all of it is reserved for subscriptions from customers in the territory served by the company. The original offering was at 82½, and about five months ago the policy of confining subscriptions to customers of the company was put in force. Soon after this the subscription price was advanced to 85, and is now advanced to 87½.

THE AMERICAN GAS COMPANY'S quarterly dividend of 2%, payable Dec. 1, is an increase of ¼ of 1% over the last disbursement, and places the stock on an 8% dividend basis. The 7% rate has been paid by the company since 1909. Prior to that time 6% was paid on the stock since 1893.

STANDARD GAS AND ELECTRIC COMPANY'S plan of financing for future developments contemplates the issue of $3,750,000 twenty-year 6% gold notes, which are offered for immediate subscription. The proceeds of $3,000,000 par value will retire all of the company's short maturity obligations, its floating debt, and furnish some additional funds, which, with the proceeds of the remaining $750,000 par value offered, will enable the company effectively to increase its earnings. The plan will not be effective unless the stockholders subscribe at least $2,000,000 of the notes. The notes are offered to the shareholders at 90, payable in cash or by installments; and are to be issued under a trust agreement authorizing a total issue of $15,000,000 and providing certain restrictions. Subscriptions will close on Oct. 15, unless the time is extended by the directors. If this proposed financing is successful—and consultation with a number of the large preferred stockholders indicates that it will be—the company's preferred stock will be immediately placed on a cash dividend basis, starting with 1% for the first quarter. The directors express the belief that the steady upward progress of the company will continue, and that dividend distribution will increase until it again reaches the 8% per annum provided for the preferred stock. The circular shows recent earnings of subsidiaries for the twelve months ended June 30, 1915, and December 31, 1914, as follows:

	June 30, 1915.	Dec. 31, 1914.
Gross earnings	$15,002,759	$14,354,689
Net earnings	7,216,909	6,741,234
Undistributed surplus and depreciation reserve	1,092,477	864,535

AMERICAN GAS AND ELECTRIC COMPANY, with gross earnings running about 18% ahead of last year, seems to be in a very strong position. Its growth is due entirely to new business, where there has been a falling off in the demand of old customers, the load created by new customers has been more than enough to fill the gap. In Marion, Munice and Elwood, Ind., and adjoining towns, business is picking up. Here the company practically has reached the saturation point in the industrial and domestic field, and therefore is not in a position to secure new business when the old falls off. In the Canton (O.) properties the August earnings were fully 30% greater than those in 1914. The season at Atlantic City was such as to bring in but fair earnings for the light and power company. The properties in Wheeling, W. Va., and Scranton, Pa., report satisfactory earnings.

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